W. land J Chas

RADIO and ELECTRONICS

ELECTRICITY — COMMUNICATIONS — SERVICE — SOUND

FEBRUARY 1st, 1950 VOL. 4, NO. 12 1/10

RADIO and ELECTRONICS

Vol. 4, No. 12 February 1st, 1950

OUR COVER

This month's cover shows an aerial view of the automatic weather reporting station on one of the small Pacific islands during the war. An article describing the operation of this station appears on page 4 of this issue. This equipment is now working in Wellington, and anyone with a receiver can pick up its signals.

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CORRESPONDENCE

All correspondence, contributions, and enquiries referring to advertising space and rates should be addressed to:—

The Editor,
"Radio and Electronics,"
Box 22,
Government Buildings P.O
WELLINGTON.

OFFICES AND LABORATORY:
Radio and Electronics (N.Z.) Ltd., 46 Mercer Street, Wellington.

TELEPHONE:
Wellington 44-919.

AUCKLAND REPRESENTATIVE:
Mr. J. Kirk,
No. 11 Keans Building,
150 Queen St., Auckland.
Telephone 48-113. P.O. Box 401.

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A New Service to Readers of "RADIO & ELECTRONICS"

For some time we have been considerably concerned about the poor quality of the technical photographs that we print to illustrate our articles. Unfortunately, the difficulties experienced are due entirely to the quality of the paper on which the magazine is printed, and not to deficiencies in the taking of the photographs. We say unfortunately because photographic troubles could be overcome comparatively easily, and, in point of fact, the originals from which the printing blocks are made are almost without exception excellent specimens of technical photography.

During the four years of our existence as a periodical, the paper position has been very grave, and at times we considered ourselves lucky to have any at all, quite apart from being able to pick and choose the kind which would be most suitable. We have also put in train arrangements for a supply of paper which, though not ideal for our purpose, will, we hope, represent a considerable advance in that photographic reproductions should print much more clearly.

Another limitation of illustrations in any magazine is that they cannot always be made as large as might be wished. With many publications this is of no great consequence, but such is not the case here. In many cases, readers rely to a great extent upon the photographs for seeing just how a set, an amplifier, or what-not is wired up, and it is disappointing and annoying if the illustrations are not clear enough to do this job properly.

In order to help readers who may have wished for better illustrations, we have made arrangements to have prints taken from the original negatives, on request, and forwarded to any address. The cost of packing and postage is included in the price of the photographs. Prices for three of the commonest sizes of prints are as follows:—

6 in. x 4 in. ...... 2/6 8 in x 6 in. ...... 3/- 10 in. x 8 in. ...... 4/6 (all post free)

We would ask readers to observe the following rules when ordering photographs:—

(1) Please print your name and address clearly in black letters, so that we will have no difficulty about finding you.

(2) Please do not forget to state the size of print required.

(3) Please state the page, issue, and volume numbers, and, where more than one photograph appears on one page, please indicate which is required.

(4) Please do not forget to remit the necessary cash with your order. Failure to do so can only cause delays in delivery.

In conclusion, we have been asked by Philips Electrical Industries to handle the photographs that have appeared in the Philips Experimenter on the same basis as the others, and so have pleasure in announcing that the same terms apply to *all* technical photographs that have appeared in our pages, the Experimenter articles included.

We hope that many of our readers will avail themselves of this new service, for we are sure it can be of very real assistance to anyone wishing to duplicate as closely as possible the designs that have been developed in our laboratory and described in *Radio and Electronics.*

* * *

Another knotty problem

While we are on the difficulties that beset the publisher of a magazine, there is another matter which has been broached by many readers and which has been in our minds constantly for more than three years now. The subject is that of binders for *Radio and Electronics.* "Surely a simple enough matter," we hear someone say; and so it would appear, until one attempts to find a firm which will make a suitable binder.

The operative word here is "suitable." We have been shown samples that are certainly excellent, except for price! We have also been shown samples whose price is reasonably low, but in which no self-respecting magazine would be seen dead! Unfortunately, the articles which we considered serviceable enough, and reasonably good-looking, were all so expensive that it would have been better to advise readers to have their copies bound by a bookbinder!

However, our researches continue, and everyone may rest assured that when we find a practical binder, at a price that would not make them blink, we will make it available at the first possible moment.

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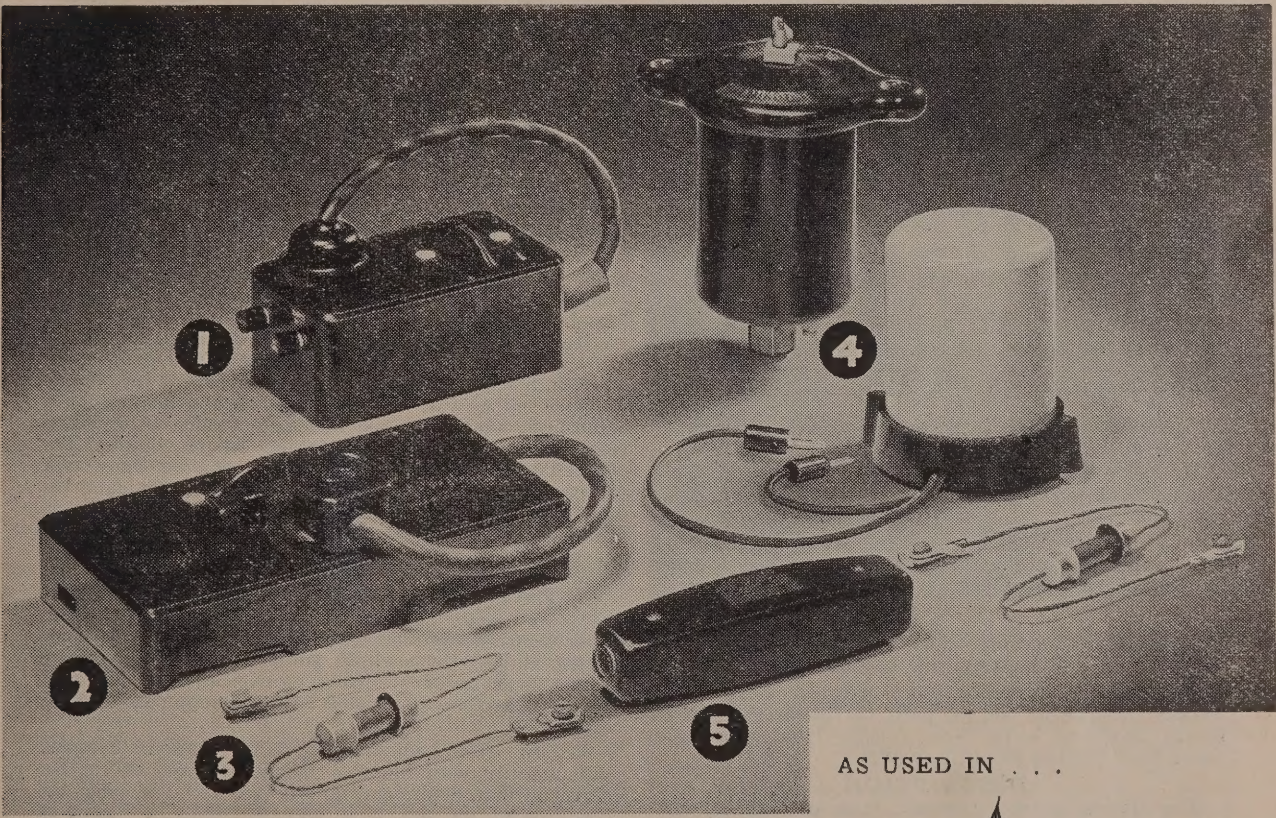

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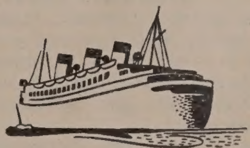

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An Automatic Weather Reporting Station

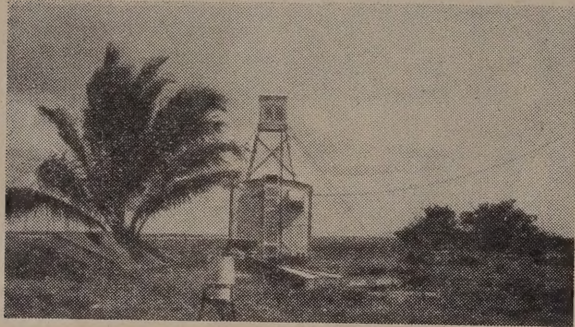
By GEORGE J. WOOD

INTRODUCTION

Since we are all interested in the weather, probably there are some radio fans who would like to listen in to ZKA on 5475 kc or 3183 kc., and, with the aid of the accompanying charts, determine for themselves what the weather is like in Wellington.

This can be done, as an automatic weather station has been set up there on test, and is broadcasting a local weather report four times a day, 6.15 a.m., 9.15 a.m., and 3.15 p.m. on 5475 kc., and 9.15 p.m. on 3185 kc.

This station was originally installed during the war by the American Navy on Long Island, one of the islets of Chesterfield Reef, which is about half way between Noumea and the coast of Queensland. Here it operated for about two years, providing weather information to the U.S. Navy Weather Service from that uninhabited area. During that time, it was serviced from Noumea by flying-boat, about once every four months.



Close-up view of the automatic weather station.

The equipment was purchased by the New Zealand Government from the United States Foreign Liquidation Commission, and in 1948 an expedition was sent by the New Zealand Meteorological Service to salvage the equipment. The expedition was conducted by the Public Works Department, and the party carried by the Department's auxiliary ketch *New Golden Hind*, was away from New Zealand about five weeks.

DESCRIPTION

The station is very compact, most of it being contained in a small, well-insulated hut, the interior of which is a 6 ft. cube, with thermostatically controlled ventilation. On the roof of the hut stands an instrument screen, which shelters the humidity and temperature reporting instruments.

Outside the hut are two lattice towers, which support the aerial and the wind direction and velocity reporting instruments, and a tipping bucket raingauge which makes a contact once for every one hundredth inch of rainfall, the number of contacts being recorded on the rain recording unit which is located inside the hut.

Inside the hut are also the power plant, consisting of a gasoline motor generator set, 12v. storage battery and 80-gallon gasoline tank; the transmitter, a conventional 30-watt crystal controlled plate modulated M.O.P.A.; a programme unit, which switches the various meteorological elements into the keying control circuit in turn during the broadcast for a period of about 45 seconds each; a pendulum clock which initiates the reporting sequence; and an automatic fire extinguisher.

Pressure, temperature, relative humidity, wind direction, and rainfall are all reported in terms of keying frequencies. The M.C.W. dashes being counted at the receiving station and the keying frequency in terms of cycles per second being applied to the appropriate graph. Wind velocity is obtained by counting the number of contacts made by the cap anemometer in a given period of time.

The report of each instrument is preceded by an identifying letter in morse code, P for pressure, T for temperature, H for humidity, D for wind direction, V for wind velocity, and R for rain.

PRINCIPLE OF OPERATION

Development of automatic weather stations has been carried out in a number of countries. France, Germany, the U.S.S.R., the United States of America, and Canada have all used them in one form or another.

The principle of operation is the same as that of the radiosonde, that weather reporting robot which is sent up to report on conditions in the upper atmosphere as high as 60,000 ft. A series of articles, commencing in June, 1947, appeared in *Radio and Electronics* under the heading of "Electronics in Meteorology" which describes very fully the different types of radiosonde transmitters. There are, in effect, miniature automatic weather stations, required to operate for only a few hours.

During the war, the Germans used a floating buoy automatic weather station to obtain weather information essential to forecasting from the Atlantic ocean. The Canadians are at present using a floating buoy type automatic weather station to obtain weather data for the forecasting of the beginning and end of fogs on Lake Ontario. This station operates on batteries which have a life of about ten months. Air temperature, water temperature, and wind velocity only are reported in this case. The French have developed a station which derives its power from the wind. That is, a wind-driven generator keeps storage batteries charged. The station report is not initiated by a clock, but by a signal transmitted at the home station, which is received by a continuously operating receiver associated with the automatic weather station.

Reports from automatic weather stations compare satisfactorily with those of manned station, except for defect in that, at present, no report is received about the condition of the sky. It is suggested that the height of the cloud base could be reported, but the amount and type of cloud presents considerable difficulty, and this information is very valuable to the forecaster.

The automatic weather station at present on test in Wellington was developed under the sponsorship of the Bureau of Aeronautics (U.S. Navy) which has pioneered investigation into the possibilities of automatic weather reporting.

Julien P. Friez and Sons Division of the Bendix Corporation, U.S.A., built the equipment. Its development was centred around the system of measurement used in the Diamond Hinman radiosonde transmitter In this system the meteorological instruments are, broadly speaking, variable resistors in the grid circuit of a relaxation oscillator. The value of these resistors is caused to vary according to the weather parameters. The squegging frequency, or frequency of interruption, of the relaxation oscillator is accordingly caused to vary along with changes of air pressure, temperature, etc.

The pulses produced by this oscillator are used to control the keying of the transmitter, calibrated charts being used to convert the resulting keying frequency to the respective weather parameters.

OPERATIONAL DETAILS

Primarily, control of the station rests with the clock. This is an accurate pendulum type operated by weights. When it is two-thirds run down, a cam operated switch closes the rewind motor circuit, so that when power is available during the next reporting broadcast, the clock is rewound. A large disc, which revolves once every 24 hours, and which has 96 holes around its periphery to take contact actuating pins, closes the gasoline motor starting circuit according to a predetermined programme. If the motor fails to start after three-quarter minute cranking, a thermal cutout operates, placing the entire station out of service until attended to. Associated with the programme disc is a cam and contacts used to change the transmitter frequency from 5475 kc., the day frequency, to 3185 kc., the night frequency. This cam is adjustable as to width of arc and time, so that a wide range of adjustment is possible.

When the motor generator has reached normal speed, power is applied to the entire circuit, but transmission does not commence until three minutes later, this being the warm-up time.

Upon application of power, 110v. A.C. and 12v. D.C., control is transferred to the sequence unit. The batteries are charged at about 6 amperes. To allow for different conditions of motor starting, the charging rate is controllable between 2 and 10 amperes.

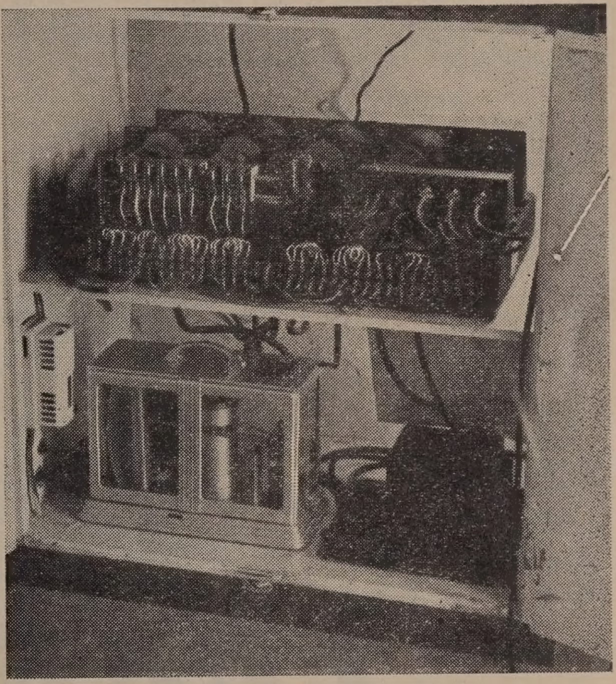
The sequence unit contains seven synchronous motors, one of which commences running as soon as power is applied, and drives a cam shaft on which the sequence is set up. At the end of two complete revolutions of this cam shaft, which requires about 15 minutes, a cam-operated micro switch opens the 12v. D.C. circuit to the gasoline motor ignition. The station is then at rest until the clock brings the next programme stud around to the starting contacts.

After three minutes of power application, the sequence cam shaft closes the first of ten micro switches associated with it, and the motor driving the call sign cam is energized. This cam makes one revolution sending the call sign ZKA three times. At the end of one revolution, the motor circuit is opened, the circuit having been maintained by a second circuit cam on the same shaft as the call sign cam and another micro switch in parallel with the initiating micro switch of this circuit. This complete operation requires about 45 seconds.

The sequence cam shaft now brings a second cam into position to operate the test frequency micro switch. This micro switch is held closed by its operating cam for 45 seconds, and operates a relay which connects into the grid circuit of the relaxation oscillator, a fixed resistor which, providing the circuit is functioning correctly, causes the oscillator to squegg at two cycles per second. If the test frequency is incorrect, adjustment to the frequencies representing the weather parameters must be made proportionately. The sequence cam shaft now closes the remaining micro switches in the following order, energizing their synchronous motors: pressure, temperature, humidity, wind direction, wind velocity, rainfall in hundredths, rainfall in inches. The cams associated with each motor send the identification letter of each meteorological instrument, complete the circuit of the switching relay associated with each instrument, and maintain their cam drive motor energized until the cams have completed one revolution. The switching relay, on operation, connects the resistor bank of each meteorological instrument in series with the grid return circuit of the relaxation oscillator. The switching arrangement of each instrument is identical, with the exception of the anemometer, which is so switched as to allow its contacts to control the transmitter keying relay direct.

In most cases, the meteorological instruments used are adapted from those in use on manned stations.

For air pressure measurement, a microbarograph is used, which has had the chart drum and drive removed and replaced by a 100 contact arc, behind which is mounted a bank of one hundred wire wound resistors. The value of these resistors is so chosen that the resultant squegg frequency of the relaxation oscillator varies in a substantially linear manner as the pen arm of the microbarograph completes the oscillator grid circuit to ground through all or any part of the resistor bank. The pen arm normally swings free of the contact arc, but is held in place against a contact by a clamping arc, which is relay operated when this unit is switched into the keying control circuit.



Part of the "works." The modified barograph is seen in the lower shelf.

For humidity, a hair hygrograph is used, the resistance bank and contact system being practically the same as that of the pressure unit. The squegg frequency in this case is proportional to relative humidity.

For wind direction measurement, a resistance bank is mounted in the wind vane housing. A cam mounted on the wind cam shaft closes any one of sixteen contacts which complete the relaxation oscillator grid circuit to ground through all or some part of the resistance bank. The graph of frequency against direction in this case takes the form of a spiral.

Rain is recorded by means of a stepping relay, which causes an arm to revolve around a circle of one hundred contacts. Each tip of the bucket in the raingauge, representing one hundredth inch of rainfall advances the contact arm one notch. The arm is clamped in place against one of the contact buttons by a relay operated clamping ring, and completes the grid circuit to ground

through all or some part of the resistor bank associated with the contact ring. One revolution of the arm represents one inch of rainfall, and a cam operated arm operating in the same way over another contact ring of twelve contacts and a resistance bank records up to twelve inches of rain, one revolution of the first arm producing one step of the record. The difference between two successive broadcasts is a measure of the rainfall during that interval.

Temperature measurement is obtained by switching a carbon resistor, having a high negative co-efficient of resistance, into the relaxation oscillator grid circuit. A change of resistance from 10,500 ohms to 28,500 ohms is obtained with a change of temperature from +40°C to 0°C.

RECEIVING PROCEDURE

This is very simple, all that is needed is a paper and pencil, a watch with a second hand, or stop watch, and a receiver which will tune to 5475 kc. for the daylight transmission and 3185 kc. for the 9.15 p.m. transmission.

First, the call sign ZKA is transmitted three times, then the reference frequency for 45 seconds, followed by P for pressure and 40 seconds of pressure frequency, T for temperature and the temperature frequency for 40 seconds, and so on, for Humidity H, Wind Direction D, Wind Velocity V, rainfall in hundredths of inches R, and rainfall in inches R.

For all except wind velocity, count the number of dashes sent in half a minute, divide by thirty to obtain frequency per second, and refer to the appropriate chart.

For wind velocity, count the number of dashes sent in 30 seconds, and multiply by two to get wind speed in knots. The anemometer makes one contact for every one-sixtieth of a mile of wind.

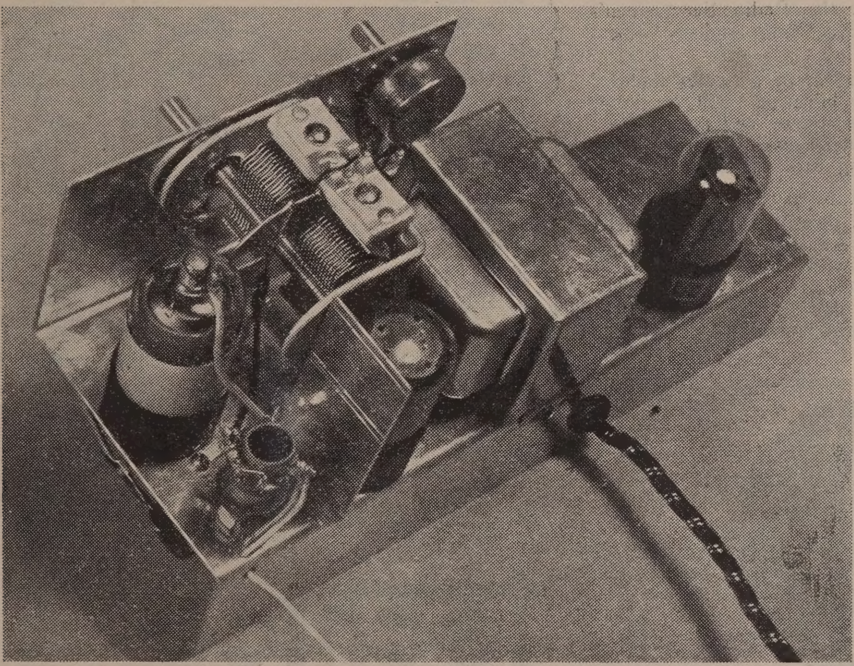
The programme is transmitted twice so that an error or interruption can be adjusted.

THE "RADEL" TRANSPORTABLE THREE

The extreme popularity of very small broadcast sets, which can easily be carried from one room to another but which do not rely on batteries as do the proper "portable," has prompted us to design this set for the home-constructor. It uses only three valves and is very inexpensive, so it should appeal to those who feel they need a second set but who are not disposed to spend too much on acquiring one.

INTRODUCTION

Since the recent war there has been a vogue for midget broadcast sets, hardly bigger than the average "portable," and yet operated from the mains. Their chief use in the home appears to be either to act as a second set which can easily be carried about the house as distinct from the main one, which is usually installed in the living-room, or else for permanent installation in, say, a kitchenette, where there is little room for one of the larger varieties.



Radio has become so much of a necessity these days that no one would suggest that it is extravagant to have more than one set in the house. Even so, full-sized sets are expensive enough to buy or build for a low-cost set to be very desirable as the "second string" receiver.

With both the above ideas in mind, therefore, we have designed a small, inexpensive set, for mains operation and with sufficiently good performance to receive the local stations well on a reasonably sized aerial. Since the objective was to get in only the local stations, we were able to dispense both with the superhet. and with two valves, and we have finished up with three valves only, one of which is the rectifier. It would have been possible to use a metal rectifier and reduce things still further, but this was not thought advisable, since retaining the valve rectifier has enabled the set to have a greater undistorted power output than it would have with the metal rectifiers currently available.

GENERAL DESCRIPTION

When a very small set is being designed, one of the chief difficulties is to get enough sensitivity for the final result to be useful without a large outdoor aerial. If, in addition, an attempt is being made to cut the cost down considerably, then the difficulty becomes correspondingly greater. First of all, it was decided that the best way of reducing the cost was (a) to use as few valves as possible, and (b) to use a T.R.F. circuit in preference to a superhet. It is only by a combination of both that real economies can be effected, for the simplest superhet., even if a reduced number of valves is used, must contain roughly the same number of component parts.

This having been decided, it is necessary to design for reasonable sensitivity, for a set that will not receive the local stations at sufficient volume is not worth having, however little it may cost! Now, sensitivity can be divided into two parts—R.F. and audio. For the first, we must choose as our R.F. amplifier a valve with as high a mutual conductance, Gm, as possible, Further, if the number of "working" valves is to be kept down to two, at least one, and probably both, will have to be dual-purpose valves. This immediately brought to mind the new duo-diode-pentode—the 6AR7-GT. The pentode section of this valve has a mutual conductance of 2.5 ma/volt, which is considerably higher than that of the previous valves of the same general type, and should allow our R.F. stage to have correspondingly more amplification. So far, so good. The next step is fairly obvious, although it was the subject of considerable thought in the design stages of the receiver. It is to use the diodes of the 6AR7-GT as the detector. Unfortunately, the diode detector gives no amplification, as do some of the older forms of detectors which naturally came up for consideration. For example, both the grid-leak detector, without regeneration, and the triode or pentode plate detectors have the virtue of giving amplification at the same time as they perform the detector's function. However, their gain is less than that of a straight audio amplifier, so it was finally decided to stick to the diode and to use a stage of resistance-coupled audio amplification in addition to the output stage.

This brings us to the choice of the second valve. None of the multi-purpose valves which contain a small triode as well as an output pentode are available, so that the choice appeared to be restricted to one of the power pentodes—preferably a high-slope, high-sensitivity one such as the newly available

(Continued on page 41.)

THE NEW ZEALAND ELECTRONICS INSTITUTE (INC.) NEWSLETTER

GENERAL NEWS

Membership Certificates:

Members will be grateful to learn that membership certificates have now been received from the printers and will be issued to financial members in due course.

Three classes of certificates on special art paper have been prepared embracing Members, Associates, and Associate Members. As considerable thought and time has been spent in the preparation of an attractive and dignified certificate, members when receiving same are requested to have them suitably framed and displayed.

Institute Prize Award:

The Institute prize awarded to the candidate who secures the highest marks in the Radio Servicemen's Examination has been won by Mr. Philip Andrew Gilbert Howell, of Napier.

The prize, which takes the form of a twelve months' subscription to a technical publication, will be made available to Mr. Howell in due course, and the Institute Executive will join with all members in congratulating Mr. Howell on his outstanding achievement.

Christchurch Members' Visit to Godley Head:

The final meeting for 1949 of the Christchurch District was to have taken the form of a visit to the Coast Regiment at Godley Head to witness a demonstration of gun-laying radar and associated fire-control apparatus. This visit was arranged for the 5th December, 1949, but at the time of going to press no further information was available.

A PORTABLE SOUND SYSTEM

By DAVID BROOK TAYLOR

(Note.—A photograph of the complete portable sound system described in this article appeared on the front cover of the January, 1949 issue of this journal.)

INTRODUCTION

This amplifier has been designed and built to be used in medium-sized halls and in private homes as a source of music for dancing and for voice reinforcement. Its main advantages are its portability, versatility, and foolproof features. The whole system—amplifier, gram-unit, microphone, etc.—is carried in the one case which is not much bigger than the usual-sized travelling suitcase. It can be carried comfortably and can be transported in trams with little or no trouble. The sound system is not a high-fidelity one, because, if it were, its performance would never be appreciated. Volume counts for more than tonal response at dances and parties, so the designer did not bother about making its response curve flat, but, nevertheless, it gives very pleasing results. Only a single 6V6 is used in the output stage, and this will be found to be quite sufficient power output; in fact, I have never had the amplifier running "flat out" at a party or dance yet! The main thing to watch in amplifiers is not the production of a great power output, but the realization of as much as possible of the available output. A sensitive speaker and a good 10-watt output transformer are the prime essentials in this sound system. Two watts of audio power at the **voice coil** of a speaker makes a lot of noise!

The amplifier is completely foolproof. Absolutely no electrical damage can be done to it by misplacement or removal of plugs. The power cord terminates in an octal female cord connector, which can be plugged only into an amplifier or into the gram-unit, so that either both or just the gram-unit can be used. If the speaker plug is removed, the power is automatically switched off, so that the output valve cannot be damaged by being left with no plate volts and, consequently, an abnormally high screen current. The gram-to-amplifier cord can only be plugged into the amplifier and its other end plugged into the gram unit. If the plugs are misplaced, the sound system will just not work, but no electrical damage can be done. There are really only two operating controls—the microphone gain control and the gram gain control, and if these are plainly labelled on the dial plates, there can be no confusion.

The amplifier can be fed from the pick-up, a crystal microphone, an electric guitar, or the midget radio tuner, and it has sufficient gain to give full output from any of these inputs. A compact phono-oscillator is fitted in the gram box, and this has proved to be a very useful addition, so that the gram unit can be used without the amplifier to play recordings by tuning it in on the house radio. At parties, the amplifier and gram unit can be used in the same room as the radio while the speaker is put in another room, or on the balcony of the house, so that the dancing is not restricted to one room.

THE AMPLIFIER

The circuit of the amplifier is quite conventional. The unit consists of a 6J7 microphone pre-amplifier feeding into a second 6J7, which has two gain controls in its grid circuit, so that either or both the

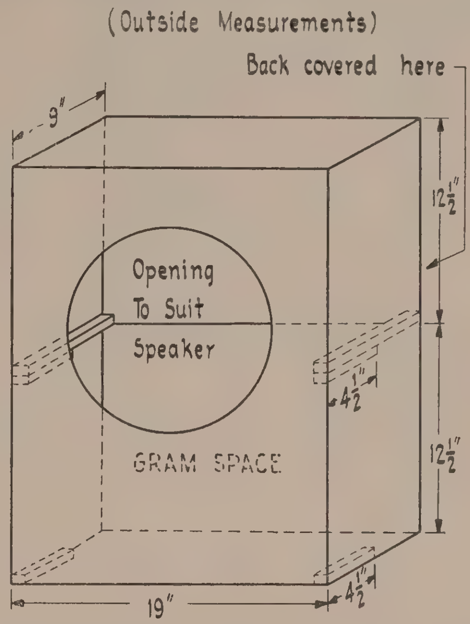


Fig. 1.—Schematic drawing of the box used as both carrying-case for all the equipment and as a speaker baffle when the system is in use.

microphone and pick-up can be "faded" in or out. This second stage drives a single 6V6 operating as a Class A1 amplifier. The power supply is quite simple, using a 5Y3 and 250-0-250v. 60 ma. transformer. A small 60 ma. choke and large filter condensers, as well as complete decoupling of stages, keep the hum-level very low. A small degree of negative feedback is introduced by a 2 megohm resistor between the plate of the second 6J7 and the plate of the 6V6, and this proves sufficient to eliminate most of the harshness from both the recordings and the voice.

The tone control is very simple, being the more or less usual 0.5 megohm potentiometer and a .005 μf. condenser for treble cut. It is intended to be used only for attenuating the scratch on noisy recordings, and should be returned to the minimum cut position on speech, because the latter should be crisp and clear if the message is to carry above the noise-level in the room. A standby switch was wired in the amplifier, switching the H.T. on or off, so that the gear could cool down a little when it was not in use, and yet so that it would be ready the moment it was required. The amplifier does not get unduly hot, but, because of its small size, there is a large ratio of heat dissipated to ventilation. Because of this, it is wise to drill several large holes in the base of the amplifier cabinet and several

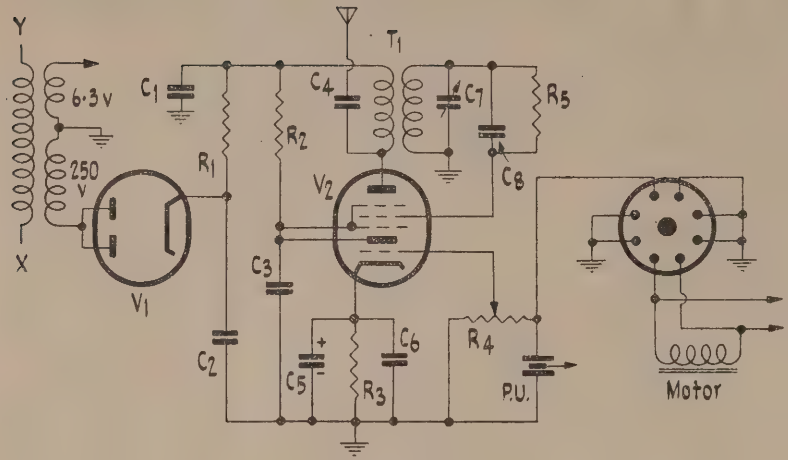


Fig. 3.— Circuit of the gramophone oscillator referred to in the text.

V_1, 6X5.
V_2, 6K8
T_1, broadcast osc. coil.
R_1, 2000 ohms 5 watts.
R_2, 50k.
R_3, 250 ohms.
R_4, 500k. pot.
R_5, 50k.
C_1, C_2, 16 μf. 450v. electro.
C_3, 0.1 μf.
C_4, 100 $\mu\mu$f. mica.
C_5, 25 μf. 25v. electro.
C_6, 500 μf. mica.
C_7, 3-30 $\mu\mu$f. trimmer.
C_8, 100 $\mu\mu$f. mica.

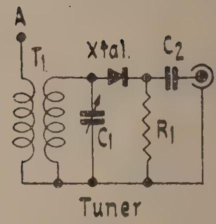


Fig. 4.—Circuit of the midget radio tuner.

T_1, broadcast aerial coil.
C_1, 400 $\mu\mu$f. solid dielectric variable.
C_2, 0.05 μf.
R_1, 500k.

smaller ones, in neat rows, along the tops of the sides and in the top. The cabinet was a small commercially made one, and was not quite big enough to hold the power transformer, so this had to be mounted on the outside of the chassis, while the output transformer is mounted in the baffle close to the speaker. A 10-watt speaker transformer was used in order to reduce, as much as possible, the usual insertion loss incurred by the average speaker transformer. A switch type gram. potentiometer was used so that the gram can be switched on or off and faded in while the other hand is used for holding the microphone. The method is to place the pick-up on the edge of the record while the motor is stopped, then the announcement is made, after which one hand can be used to switch on and fade in the gram. and then to fade out the microphone. Don't fade the gram. in too quickly, thereby not giving the motor time to pick up speed, or the start of the recording will sound rather "sick." Although the motor switch is on the back of the gram. pot. and the power leads to the gram. unit are in the same cable, there is no noticeable increase in hum, providing, of course, that the usual shielding precautions are made and that the gram. to amp. cable is not too long.

THE PHONO OSCILLATOR

The main advantage of the oscillator is that it is not necessary to bother about making connections to the radio from the pick-up. Just plug the mains into the gram. unit (using the amplifier power cord) and switch on the oscillator. After a few seconds' warming-up period, it is ready for use. Of course, the oscillator is really just a luxury, and therefore it need not be built unless the pocket can comfortably produce the extra cash necessary. Electrically, it is quite simple. A 6K8 is used as an oscillator at broadcast frequencies by means of its plate and signal grid, while the pick-up modulation is fed to the oscillator grid. The power supply is a midget 250v. 30 ma. half-wave power transformer, 6X5 half-wave rectifier, and a "brute force" filter. The oscillator is pre-tuned by fixed mica condensers, and a standard 30 $\mu\mu$f. trimmer to a vacant part of the broadcast band, so that it will not interfere with, or be swamped out by, the stations. Almost any coil can be used—R.F. aerial or oscillator type—providing it will tune to some part of the B.C. band.

In this particular model, a standard B.C. oscillator coil was used. If aerial or R.F. coils are used, turns will have to be "peeled off" the primary winding until the 6A8 just oscillates. Some experimenters might like to try by using a midget portable loop aerial coil, so that an aerial wire would be unnecessary. The gain or modulation control can be brought out to the panel or left as a pre-set control. It must be remembered that this control sets only the modulation level, and does not act as an R.F. output control varying the range of the oscillator, as some people think. If the circuit of the oscillator is followed exactly as shown, three to four feet of wire will prove to be ample as an aerial.

THE RADIO TUNER

As an experiment, a midget crystal set was made with the idea of keeping the music going at parties, during supper, or while the operator was otherwise engaged. It was connected in place of the microphone, and, taking its limitations into consideration, it proved to be quite a success. Unfortunately, in Wellington, it was not much in use between 7 and 10 p.m., because the selectivity was not good enough to separate 2YD from 2ZB, but, after the former

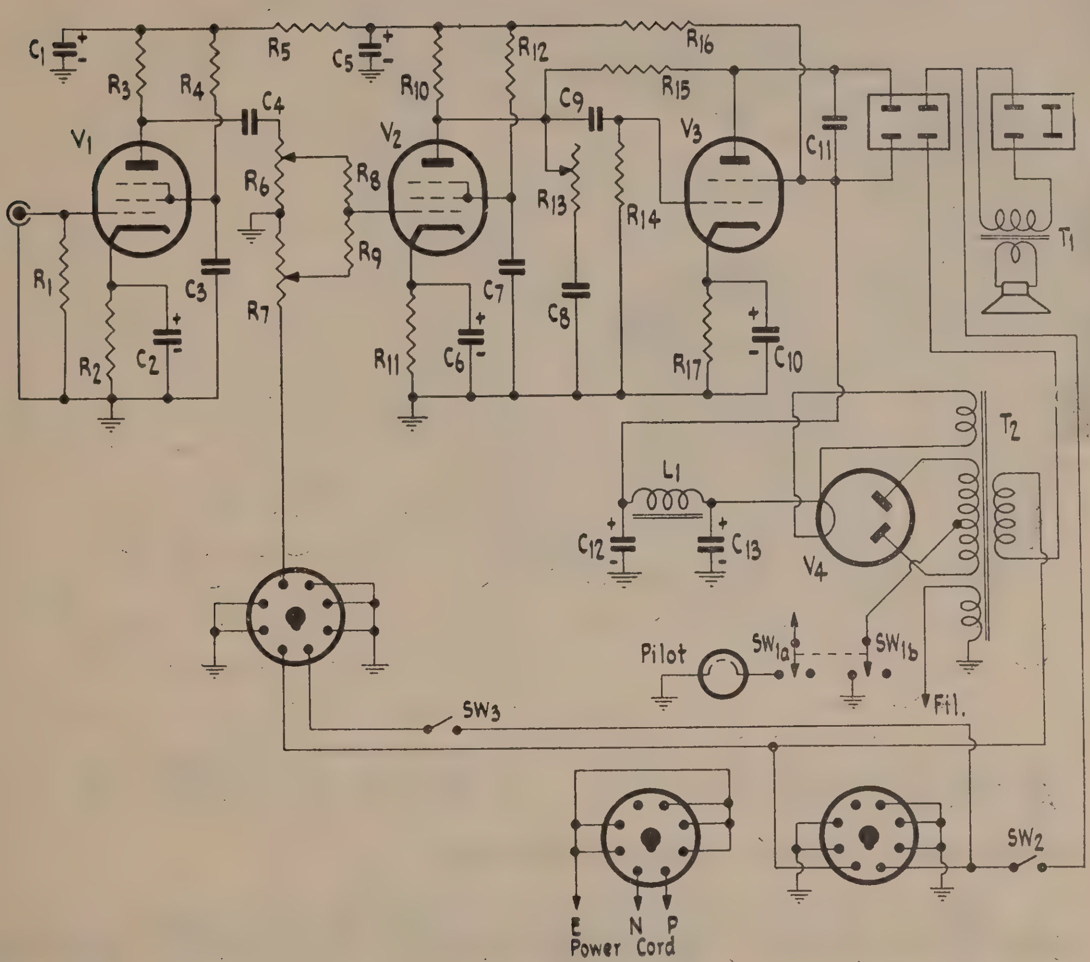


Fig. 2.—Main circuit diagram.

V_1, V_2, 6J7.
V_3, 6V6.
V_4, 80 or 5Y3.
R_1, R_8, R_9, R_{14}, 500k.
R_2, R_{11}, 1000 ohms.
R_3, R_{10}, 250k.
R_4, R_{12}, 1 meg.
R_5, R_{16}, 25k.
R_6, R_7, R_{13}, 500k. pot.
R_{15}, 2 megs.
R_{17}, 250 ohms.

C_1, C_5, C_{12}, C_{13}, 16 μf. 450v. electro.
C_2, C_6, C_{10}, 25 μf. 25v. electro.
C_3, C_7, 0.25 μf. 400v. paper.
C_4, C_9, 0.25 μf.
C_8, 0.005 μf.
C_{11}, 500 $\mu\mu$f. mica.
T_1, output transformer, 5000 ohms to V.C.
T_2, 250-0-250v. 60 ma. power transformer.
Sw_1, D.P.D.T. operate/standby switch.
L_1, 60 ma. smoothing choke.
Sw_2, Sw_3, S.P.S.T. toggle switches.

goes off the air, 2ZB and 2YA came in well, with fidelity that was quite satisfactory. The tuner was built in a small metal box, about 3 in. x 2½ in. x 1 in., and it used a midget single 400 $\mu\mu$f. bakelite dielectric condenser, a 1N34 germanium diode, a resistor, and a condenser—only a few shillings in value. Only 10 feet of wire lying on the floor was a sufficient aerial to obtain the above results. No earth connection is necessary for the tuner, since it is earthed through the three-pin mains plugs.

GENERAL

When the amplifier is not in use, its power cord can be used to operate just the gram. motor and the phono oscillator. Make sure that the octal cord connectors are wired up carefully and that the metal covers are earthed to remove any possibility of shorts occurring or shocks being received from the plugs. The mains cord for the amplifier was cut 20 ft. long, and then an extension cord also 20 ft. long was made, because in some homes and halls the power sockets are few and far between, and when they are few they are generally a long way from the places where they are most needed. The amp. to gram. cord should be kept as short as possible, otherwise hum will be induced in the pick-up lead, even though the latter is shielded. In the designer's amplifier, this cord was made 4 ft. long, and was found to be ample. The speaker cord was a 40 ft. length of twin plastic lighting flex. If the speaker is used close to the amplifier, the unwanted length of cord can be coiled up and tucked in the back of the speaker box. The speaker is a medium duty 10 in. P.M. type, which is capable of handling the output of the amplifier comfortably. The only disadvantage in using one speaker is that the coverage is not very good, but if the speaker cabinet is hung from the rafters in the centre of the hall, it will be found to be quite satisfactory in most cases. There is no reason why two speakers, in separate cabinets, should not be used to obtain a better distribution of the sound, provided, of course, that a suitably tapped output transformer is used, but, if this is done, the equipment loses its main advantages—portability and compactness.

THE CABINET

The speaker cabinet was made of ½ in. timber, while the gram. unit had ½ in. sides and three-ply top and bottom. It will be noticed that, when the box is standing upright, it sits on four rubber feet, and also that there are a further four rubber feet on one side, while a carrying handle is fastened on the opposite side. As will be seen from the drawings, the cabinet is 25 in. high, 19 in. wide, and 9 in. deep. Half the back is covered, leaving one opening 12 in. high and 18 in. wide into which the gram. unit fits, thereby completely covering the back. The gram. unit measures 18 in. wide by 12 in. deep and 4 in. high. Four corner blocks 4 in. long are fitted inside the cabinet to stop the gram. unit from being pushed too far inside. Incidentally, the pick-up clamp is made simply by drilling a hole in the P.U. and then a hole is drilled and tapped in the P.U. rest, so that a screw can be pushed through the P.U. and into the rest, clamping the former down.

When the gear is being packed up, the cabinet is placed on its side in the carrying position, and the amplifier and cords, etc., are placed inside the spare space behind the speaker. Then the gram. unit is

(Concluded on page 48.)

THE "RADEL" AUDIO SIGNAL GENERATOR

(Note.—Parts 1 and 2 of this article, containing full circuit diagram, circuit values, and photographs of the finished equipment, appeared in the December 1949 and January 1950 issues of this magazine.)

PART 3

MATCHING THE RESISTORS

The best pair to start off with is the 1 meg. for the intermediate frequency range. To match them, it is necessary to have a better kind of measuring device than the ordinary ohmmeter, which is far too inaccurate for the purpose. The best instrument to use is a microammeter, which should be as sensitive as possible, preferably 50 or 100 amps full-scale.

If you do not possess one, a 10,000 or 20,000 ohm-per-volt multimeter should be begged or borrowed. The method of matching is simplicity itself. The resistors are connected one at a time, in series with a suitable voltage source and the meter. The voltage used can be made as high as it is necessary to obtain an easily read deflection on the meter that is available. For instance, if only a 1 ma. meter is available, a 500v, source will give half-scale deflection with a 1 meg. resistor, but if more sensitive meters are available, correspondingly less voltage can be used. Resistors are tried in the test circuit and the current reading for each is noted until two are found that give exactly the same reading. This method of matching is as accurate as the meter used, and should be able to give results in which the resistors are matched to within 1 per cent.

The difficulty of not having a very sensitive meter is likely to arise only with the 10 meg. pair, because here a voltage of 500 will give a current of only 50 μamps, which is usually $2\frac{1}{2}$ small divisions on the scale of the average 0-1 ma. meter. Even so, matching with these tools is a great deal better than no matching at all, and will be accurate enough. The more sensitive meter merely gives a more easily read answer.

PUTTING THE OSCILLATOR INTO ACTION

After the resistors have been matched and installed in the circuit comes the job of adjusting C_{10} to the best setting. First of all, it should be set to approximately three-quarters of its maximum capacity and the power turned on. The output should be monitored with an oscilloscope connected at the plate of V_4, preferably without an amplifier, since this will almost certainly have too much droop in response at high and low frequencies for giving the real answer about what the oscillator is doing. The output will be great enough to give a quite useful deflection without the use of the Y-axis amplifier, so that the latter is not needed in any case.

First of all, the range switch, S_1, should be turned to the middle position, when the frequency range will be approximately 300 to 3,000 c/sec. The main dial is now set in its mid position, and the oscillation control, R_6, is advanced until oscillations start. It will be found that, with the control fully advanced, the output meter will read somewhere near full scale, and also that the output waveform is noticeably distorted. Now, if the oscillation control is slowly retarded, the output voltage drops, gradually at first, until a point is reached where the oscillations collapse quite suddenly. Before this point is reached, however, and while the amplitude is quite steady, the distortion disappears completely, as far as the eye can tell; it is in this condition that we want to operate the oscillator, because, when it is just going and no more, the waveform is very pure, and thus contains only a very small percentage (less than 0.5 per cent.) of total harmonics.

During the initial adjustment, the dial has been set at half-scale. The next thing to do is to set the oscillation control so that the oscillation is steady and the waveform good, and then to turn the tuning dial. It will probably be found that at one end of the scale the oscillation is more violent, resulting in distortion, and at the other the oscillator either tends to—or actually does—drop out altogether. It may be that by chance oscillation ceases at both ends of the band, in which case it is necessary to tread warily in adjusting the trimmer, C_{10}, and to note what difference this makes to the performance at the ends of the band. If the change was in the right direction, the oscillation level will be more constant over the band, but if it was in the wrong direction, the differences will be more marked than before. When in this way a setting has been found for C_{10} which causes the output to drop off equally at each end of the band compared with the middle, the correct setting has been found. It will then be possible to set the level to approximately 300 on the 500 μamp. output meter at all parts of the dial simply by adjusting the control, R_6.

Next we turn to the low-frequency band. Here it can be expected that the output will fall rather more at the ends of the band than it does on the middle band, and also that a somewhat higher setting of R_6 is needed to give the same output. However, reference to the scope pattern will show that at all frequencies the waveform is equally good when the output level is set to the same mark on the output meter. On the low band it may be necessary to make a very slight and careful adjustment of the trimmer condenser, C_{10}, in order that oscillation of the right strength may be had all over the dial, but it should be emphasized that this adjustment will be very small indeed, and not large enough to produce a noticeable change in the behaviour on the middle band. All we need to worry about is to get C_{10} so adjusted that the right output voltage can be got at some setting of R_6. With an incorrect setting, it may be found that at some part of the dial there is no oscillation even with R_6 at minimum resistance. It will be noted in this connection that R_6 is only 100 ohms, while R_5 is 700 ohms. It is therefore possible to get more control by keeping the sum of these resistors constant at 800 ohms, but altering their values to, say, 600 for R_5 and 200 for R_6. We have, however, not done this, because the control would then be more sudden, and it would not be so easy, once C_{10} has been adjusted, to set the output to the same level at all frequencies.

BUILDING THE ATTENUATOR SECTIONS

All that remains to do now to complete the oscillator is to choose the resistors for the attentuator sections, and install them in the circuit. In a T-attenuator, such as the three that are used here, the resistors have to be chosen so that two quite different requirements are fulfilled. First, the attenuation must be of the required amount, and secondly, the input and output impedances must have the corect value so that the various sections may be connected in cascade (*i.e.*, one feeding into the other) without altering the voltages throughout the earlier sections. It is not our purpose here to show how the correct values can be calculated, but only how the right values can be selected after the calculation has been

done. Reference to the circuit diagram in Part I of this article will show that the two 20db. sections are identical, and that the values are 820 ohms for the horizontal arms of the "T," and 202 ohms for the upright arm. These values are correct to three places of decimals, and it will not ordinarily be possible to adjust them to this degree of accuracy, but the values have been given thus to show that the required values do not have the consideration to come out to round figures that are also standard resistor values. Thus, we will have to buy resistors as close to these values as possible, and then, to adjust them as well as we can.

ADJUSTING THE RESISTORS

How, then, can this be done? Quite simply when it is known how, and the only tools needed are a hack-saw, a battery, and a milliameter. First, a little calculation of Ohm's Law tells us that 2 volts across 820 ohms gives a current of 2.44 ma. Now an accumulator that is on the major portion of its discharge curve has a voltage that is 2 volts, quite accurately. If it is freshly charged, or run down, the voltmeter will tell us so, but in performing this test for the resistors it is better to rely on the voltage of the accumulator than on the reading of the voltmeter, unless this is accurate to 1 per cent. or better. This is because the current ranges of a multi-meter are usually more accurate than the voltage ranges. Thus, we connect a resistor that is nominally 800 ohms in series with the 2-volt cell and the milliameter, on a range of 0–5 ma., or 0–10 ma. Having done this, we read the current indicated. If this is 2.44 ma., as nearly as we can judge, then the resistor is 820 ohms, and will need no adjustment. If the current is less than 2.44 ma., the resistor is too high in value, and is useless for our purpose, as we have no means of lowering the value—only of raising it.

Suppose, therefore, that we have found a resistor which passes, say 2.6 ma. in the test circuit. Its value would incidentally be 767 ohms, but we are not interested in this particularly. The resistor is then clamped in the vice between pieces of wood, and, with the circuit still operating, so that the current can be read while the adjustment is in progress, a small cut is made in the resistor with a hack-saw. Needless to say, only one type of carbon resistor responds to this treatment at all successfully, because the scheme obviously will not work with any but the kind which comprises only a composition rod, painted over with the coding colours, so make sure that this is the type you buy for the purpose, and not the kind that is encased in a ceramic tube which is not part of the resistor at all.

As the cut is made deeper, the value of the resistance increases, and the current can be seen to decrease while the cutting it going on. If the right value is not reached after the cut is $\frac{1}{8}$ in. or so deep, it is best to start another one, at the other end of the resistor; this avoids weakening the rod too much. When the correct value is reached, the cutting is stopped, and the bare surface is given a light coat of varnish or polystyrene dope, in order to prevent the ingress of moisture.

All six resistors are adjusted in the same way. The 200-ohm ones are adjusted to a current of 10 ma., this giving them a value of exactly 200 ohms, the extra 2 ohms being disregarded.

After the individual values have been adjusted in the above manner, all that has to be done is to wire up the attenuator circuit, after which a test will show that the correct attenuation is secured without further adjustment of any sort.

THE FIRST ATTENUATOR SECTION

In the main circuit diagram of the instrument, the first section of the attenuator, whose resistors are labelled

(Concluded on page 48.)

DYNAMIC NOISE SUPPRESSION ONE OF THE LATEST ADVANCES IN AUDIO TECHNIQUE

Dynamic noise suppression is the name given to a new method of reducing, if not eliminating, the surface noise and other disturbances which do much to mar enjoyment of modern high-quality gramophone recordings. Although the equipment for bringing about this desirable result is a little complicated, the principle on which it works is not, and this article is devoted to describing its benefits and how it works. A circuit is also given, so that constructors may try their hands at something quite new, with interesting possibilities for the amateur experimenter.

INTRODUCTION

As we have remarked before, one of the most disheartening things about improving one's audio equipment is the way in which better and better speakers and amplifiers give better and better reproduction, not only of the programme, but also of surface noise, turn-table rumble, and distortions of various kinds, which are not attributable to our own equipment, but which are present on the discs we play.

In short, unless records are singularly free from distortion and noise, a vastly improved reproducing system can, and often does, give much worse-sounding results than before. Whereupon, who can blame us if we tend to throw in the sponge, as it were, and affirm that high-quality reproduction is impossible!

It is this unfortunate fact that has spurred a number of people on in attempts to perfect a system in which surface noise is suppressed. Ideally, of course, the best line of attack is to improve the recordings themselves, so that the noise is reduced, or absent altogether, but since we have no control over the records we must play, this is clearly impracticable, and our own efforts must be concentrated upon the gear used, instead.

The idea of equipment which will automatically cut out surface noise is not new, and several attempts have been based on the fact that the noise is most troublesome only on those parts of a record where the level of the music is relatively low. On the more heavily recorded passages, the modulation tends to swamp the surface noise, which is thus not troublesome at these times. The well-known volume-expander is one of these schemes, because it causes the greatest amplification to occur only when the surface noise is least troublesome, but is not particularly effective as a noise suppressor, although its characteristics are highly desirable from other points of view. Other schemes of noise reduction have been in the nature of automatic tone controls, which restrict the frequency response of the amplifier during quiet passages in the music, and expand it again during loud passages. However, these have not enjoyed a great deal of success either, for reasons which we will attempt to make plain, and there is no doubt that to date, the most promising system of noise reduction is the Scott Dynamic Noise Suppressor.

WHAT IS WRONG WITH OTHER SYSTEMS

Earlier attempts to eliminate noise automatically, all fell down because the methods used could not discriminate between the noise itself and the musical sounds whose frequencies lie in the same portion of the audio range as the majority of the noise signals. For example, any attempt to reduce the noise by means of an automatically-operated treble-cut kind of tone control is doomed to failure for exactly the same reason that a manual tone control of the same kind fails to satisfy the listener. That is, that the high notes are eliminated along with the noise when a tone-control is used. Further, if one tries to operate the automatic control by using the presence of musical frequencies above, say, 4000 c/sec. to open out the response of the amplifier, the scheme fails because most of the noise itself is above 4000 c/sec., and triggers off the operating circuit, which cannot discriminate between noise and musical tones.

The volume expander does not suffer from this fault, because it makes no attempt to vary the frequency response, but as a noise reducer it fails because the rise and fall of the noise, as the expansion works, draws the listeners' attention, and focuses it upon the very noise which it is trying to reduce.

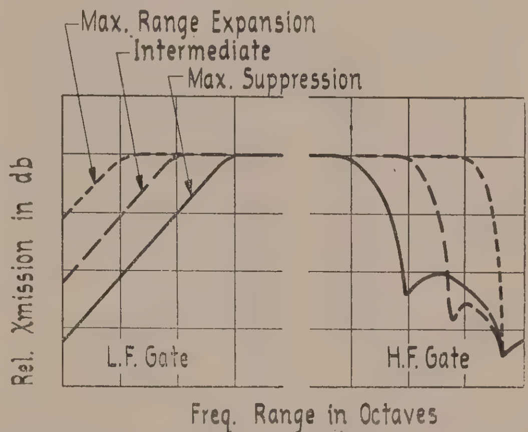


Fig. 1.—Graphical description of what the dynamic noise-suppressor does. The inside and outside curves represent the extreme frequency response curves, between which the response varies in accordance with the requirements of the music.

WHAT IS NEW ABOUT THE DYNAMIC NOISE SUPPRESSOR?

Judging by the above, it would seem that any system which, like this one, claims to be successful, must employ a new principle, and this is quite definitely the case. Briefly, the principle of the noise suppressor is similar to the automatic tone-control kind of thing, except for two very important differences. First, the frequency response is adjusted, not simply to roll off gradually, as happens with the usual tone-control circuit, but to be sharply cut off at a predetermined frequency, by the use of a comparatively complex filter network. Secondly, (and here is the crux of the whole matter) the frequency response is widened *in accordance with the requirements of the music that is being played,* and also, *the control is exerted by features of the music, quite distinct from the noise.*

Now this may seem a fairly tall order, and so it is,

which speaks very well for the technical ingenuity of the inventor of the system, H. H. Scott.

JUST WHAT THE SUPPRESSOR DOES

The manner in which the scheme works is well illustrated by the graphs of Fig. 1. Here we have three frequency response curves, one full, the second drawn in large dots, and the third in small dots. Suppose we have an audio amplifier whose response corresponds to the third of these curves. This, we can imagine, covers from 20 to 20,000 c/sec., at the points where the sharp drops occur in the low and high-frequency response. By some means as yet undisclosed, it is possible to vary the rseponse between the small-dotted curve, and the full-line curve, with the large-dotted curve representing some intermediate response such as is reached under the appropriate conditions of use.

Further, unless the music being reproduced calls for an expansion of the frequency response curve, the full-line curve is in force, with the result that noise occurring in the range above the cut-off frequency of this curve is not reproduced. Similarly, turntable rumble, which occurs at the low-frequency end of the scale, is also suppressed because of the limited bass response. The bass is controlled independently of the "top," by an entirely separate control circuit. The nett result of all this is that the frequency response of the amplifier adjusts itself automatically to a range that just accommodates the signals that the amplifier is handling at the moment. When extended high-frequency or low-frequency response is called for by the music, the control circuits come into play automatically. In short, the performance with respect to noise is similar to that of an amplifier with heavily attenuated bass and treble, *without* the same limitation being applied to the music itself.

HOW IT IS DONE

It is well-known that sharp cut-off cannot easily be obtained with ordinary resistance-capacity networks, such as are used wherever possible in tone-control circuits. If sharp cut-off is required, like those illustrated in Fig. 1, the only practicable way of getting it is by using filter sections containing inductance and capacity. This is a nuisance, because R.C. filters are much easier to construct, but luckily, quite simple L.C. filters suffice, and the basic types used in the dynamic noise suppressor are shown in Fig. 2. At (A) is a low-pass filter section used to pass all frequencies below a predetermined figure, and cut off all above the same figure. At (B) we have a high-pass filter, which gives a characteristic resembling the low-frequency parts of the curves of Fig. 1. Theoretically, if we wish to vary the cut-off frequency of a filter to give the variable performance illustrated in Fig. 1, all circuit elements in the filter should be varied simultaneously. Even with a simple filter such as Fig. 2 (A), this would be an impossibly complicated job, and the basic scheme would be unworkable were it not for the fact that quite satisfactory performance can be obtained by varying only one of the five components—in this case, C_2. Similarly, the low-frequency response can be varied quite well by altering only the inductance of the choke in Fig. 2 (B). This simplification makes the scheme practicable, especially when it is remembered that a reactance valve, such as is used to frequency-modulate an oscillator, can be made to behave like a variable condenser, or a variable inductor, at will. Thus, in a practical circuit, all we need to do is to set up two filters, as in Fig. 2, and in each of them provide a reactance tube, which can be made to vary the filter characteristics according to the dictates of a suitable control circuit. At bottom, therefore, the system of the noise suppressor is no more difficult to understand or to operate than that of a volume expander. In the latter, a control circuit is set up and is made to vary the amplification of a suitable amplifier circuit. In the dynamic noise suppressor, the control circuit is made to vary the frequency response curve of the amplifier instead of its amplification. A little more complexity is apparent here, however, because we want to control bass and treble independently of each other, which makes the complete noise suppressor comparable to two volume expanders in the amount of gear used, but no more difficult in principle. At this point in our discussion we can profitably examine the type of control circuit used in the

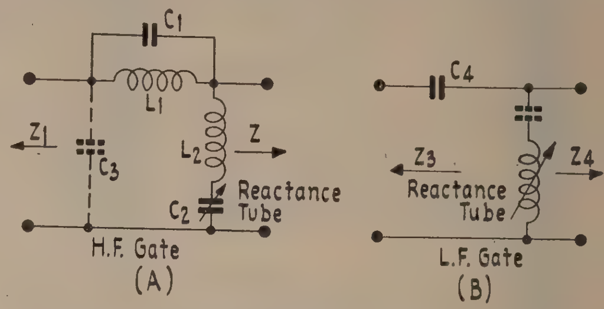
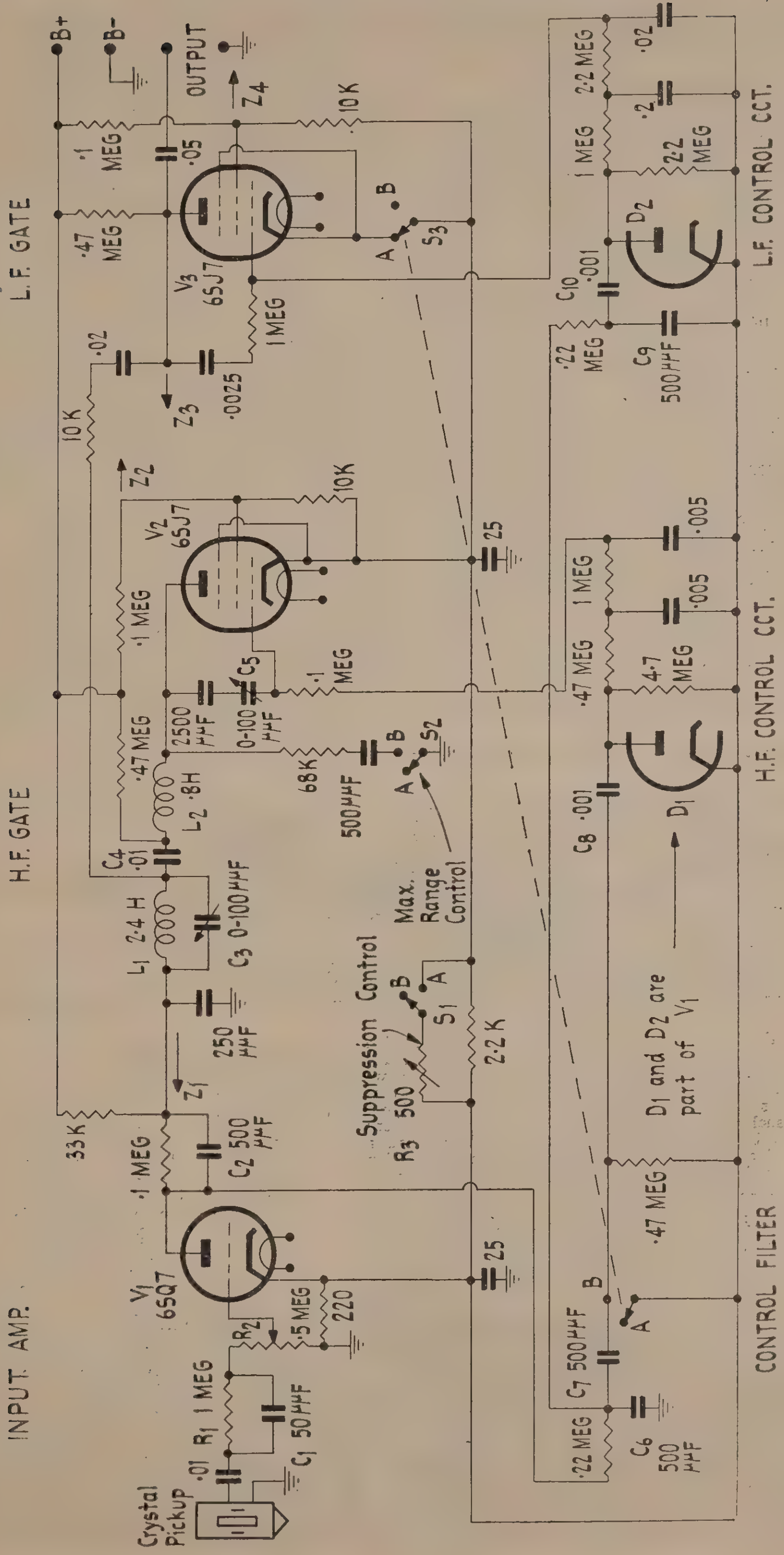


Fig. 2.—These are the basic circuits that expand and contract the frequency response curve of the amplifier. Filter (A) passes low and high frequencies up to a limit determined by the value of C_2 which is electronically varied by a control voltage derived from a rectifier. Filter (B) passes high and low frequencies down to a limit determined by the value of L, which is also a rectifier-controlled reactance valve.


INPUT AMP.
H.F. GATE
L.F. GATE
CONTROL FILTER
H.F. CONTROL CCT.
L.F. CONTROL CCT.
Crystal Pickup
V1 6SQ7
V2 6SJ7
V3 6SJ7
B+
B-
OUTPUT
Suppression Control
Max. Range Control
D1 and D2 are part of V1
L1 2·4 H
L2 ·8H
C3 0-100 μμF
C4 ·01
C5 0-100 μμF
R1 1 MEG
C1 50 μμF
C2 500 μμF
C6 500 μμF
C7 500 μμF
C8 ·001
C9 500 μμF
C10 ·001
R2 ·5 MEG
R3 500
S1
S2
S3
Z1
Z2
Z3
Z4

suppressor, because it is here that the important principle is put into practice of using the signal itself to control the frequency response.

THE CONTROL SYSTEM

Since the bass and treble controls are quite separate in the equipment, they can be considered separately also, so we will confine ourselves for a start to the high-frequency end, which is the most important. As was pointed out above, it is not possible to use the high-frequency components of the music with which to control the high-frequency response of the amplifier, because most of the noise that we want to eliminate also occurs in this range, and would cause the "gate" circuit to open, and would thus let itself through, spoiling our efforts completely. Fortunately, however, there is a way out of this dilemma. It depends for its success on the fact that the extreme high-frequency output of all musical instruments consists *not* of fundamental notes played by the instruments, but of *harmonics* of the highest fundamental notes played. In other words, it is only when instruments are playing in their upper registers that an extended high-note response is needed at all. Furthermore, it is possible to derive our control voltage for opening the high-frequency gate *from the medium-to-high audio frequency range—say from the range 1500 to 2500 c/sec.* Our control circuit, whose job it is to open the high-frequency gate must therefore consist of a rectifier fed with audio frequencies within this range, but not outside it. Luckily, this can be done quite well enough by using a simple resistance-capacity filter in front of the control rectifier.

The low-frequency gate can also be operated by frequencies outside the range which contains the bulk of the low-frequency noise, by relying on another principle. This time it is that practically all very low-frequency musical notes are accompanied by a goodly proportion of harmonics. For example, a bass drum has a very wide spectrum, which includes harmonics extending practically throughout the whole audio range. It is thus possible to use some of the lower harmonics, say those between 500 and 1000 c/sec., to provide a control voltage for opening the low-frequency gate.

Now that the principles behind the working of the dynamic noise suppressor have been outlined, it is possible to look at the full circuit diagram of a practical unit, and see just what is involved.

THE FULL CIRCUIT

Fig. 3 is the complete circuit of a dynamic noise suppressor, as given by H. H. Scott in *Electronics,* where details were first published.

V_1 is a high-gain triode amplifier stage, fed from the gramophone pick-up. To the right can be seen the low-pass filter, in which L_1 and L_2 correspond to the similarly marked chokes in the skeleton diagram, Fig. 2 (A). The first 6SJ7, V_2, is a reactance tube corresponding to C_2 on Fig. 2 (A). Further to the right still is the high-pass filter, with a second 6SJ7 acting as an inductive reactance tube.

From the plate of V_1 comes the simple filter network which divides the spectrum up in the appropriate way to feed the two control rectifiers, D_1 and D_2. The control circuit filtering is actually in three parts. First of all comes the 0.22 meg. resistor and C_6, of 500 $\mu\mu$f. This is a simple low-pass filter section designed to pass everything below about 5 kc/sec. Thus, after this point, there is very little high-frequency noise, and what there is

will not be great enough to operate the control rectifiers. Next we have C_7, followed by a 0.47 meg. resistor. This forms a short time-constant coupling circuit to the high-frequency control diode D_1, and prevents all but the upper middle portion of the audio range from working the rectifier, as was described earlier. Then, branching off from the same point is a further low-pass filter section, consisting of a further 0.22 meg. resistor and C_9. This further attenuates the upper range, and ensures that the same part of the spectrum which works the high-frequency gate will not work the low-frequency one also.

Following each control rectifier is a two-stage filter. These filters are similar to the ones to be found in a volume expander following the control rectifier, and their purpose is the same, namely to ensure that the control voltage is as nearly pure D.C. as possible, and does not contain a residue of audio frequencies which would be fed back into the signal portions of the circuit. It will be seen that the control diodes are those belonging to the 6SQ7, V_1, so that although there is plenty of circuitry, only three valves are used, which helps to reduce the cost of the unit.

A number of switches are incorporated in the unit so that various types of operation are made possible. S_1, when in position B, opens both gate circuits permanently, and gives maximum frequency response for those records which can use it. When S_1 is closed, R_3 acts to control the degree of suppression, and should thus be on the front panel of the instrument. S_2 serves to restrict the response still further at the high-frequency end, and is useful for playing very bad records. S_3 is not essential, but is useful for demonstration purposes, as it closes the high-frequency gate, leaving the low-frequency gate open. It therefore simulates the effect of having a fixed high-frequency filter, such as a scratch filter, together with no suppression of low-frequency noise.

ADJUSTMENT OF THE UNIT

When the unit has been wired up, it is necessary to adjust C_8 and C_5, and to do this an audio oscillator, or a frequency record, together with an output indicator, will be needed. R_3 is first set at zero, and S_1 is closed. S_2 is open, and S_3 is in position A. Then, with an input fre-frequency of 9000 c/sec., C_8 is adjusted for *minimum* response. Next, S_3 is thrown to position B, and C_5 is adjusted for minimum response at 4000 c/sec. Adjustment is now complete, and the unit is put into operation, and various settings of R_3 are tried in order to find the best average setting, and the settings that work best with records of better, and worse than average surface noise.

INDUCTORS

One of the difficulties connected with building the dynamic noise suppressor is that of obtaining suitable filter inductors. Since the inductances are quite large, namely 2.4 and 0.8 henries respectively, they will need to be iron-cored, although they were not drawn that way on the original circuit diagram which we have reproduced here. Anyone who is interested in building a dynamic suppressor for himself should approach one of the firms which specialize in transformer manufacture (in particular, audio work) and ask them to quote for building the chokes. The cost should not be high, since L_1 has to carry no D.C. at all, and works only at low flux density, while L_2 has to pass only a few milliamps of D.C., and also works at low A.C. flux density.

(Concluded on page 48.)

FOR THE SERVICEMAN

ULTIMATE 5-VALVE RADIOGRAM CONSOLETTE MODEL R.A.F.

Circuit:

A type 7A8 octode frequency changer is followed by a type 7A7 R.F. pentode employed as an intermediate frequency amplifier which is in turn coupled to a type 7C6 duo diode triode combining the functions of demodulation, a.v.c. rectification and voltage amplification. Resistance coupled to this stage is a type 7C5 beam power amplifier delivering approximately 4.2 watts to a Rola type 8H speaker. A type 6X5GT is employed in the power supply as a full-wave rectifier.

The gramo motor used is a Garrard type AC6 type E and the pickup is a Garrard magnetic type.

I.F. Alignment Procedure:

A signal generator modulated 30 per cent. at a frequency of 400 cp/s is coupled between the control grid of the 7A8 frequency changer and ground by means of a 0.1 μf. condenser. I.F. transformer should be adjusted for maximum output by means of the iron cores in the following order, I 6, I 5, I 3, I 4. An input of approximately 50 μv. should produce an output of 50 milliwatts.

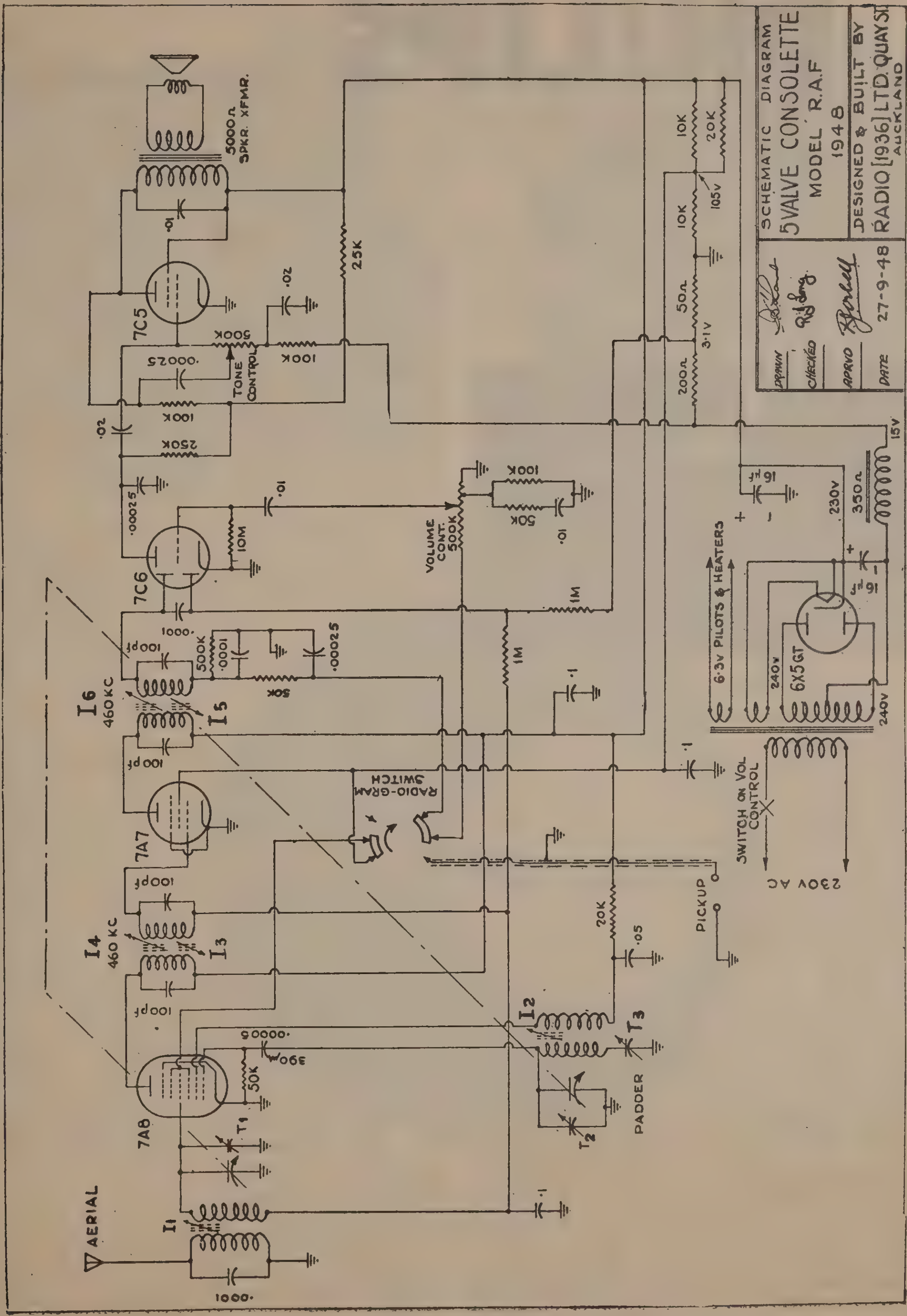
Calibration:

Adjust 1400 kc/s. point by means of trimmer T2 and 600 kc/s point by means of padder T3. Adjust 1000 kc/s point with iron core I 2. Intermediate points should be checked and oscillator section of ganged condenser fanned to correct frequency.

R.F. Alignment:

A signal generator modulated 30 per cent. at 400 cp/s is coupled to the antenna and earth leads by means of a standard dummy antenna.

Adjust 1400 kc/s point by means of trimmer T1 and 600 kc/s point by means of iron core I 1.


SCHEMATIC DIAGRAM
5 VALVE CONSOLETTE
MODEL R.A.F
1948
DESIGNED & BUILT BY
RADIO [1936] LTD. QUAY ST.
AUCKLAND
DRAWN
CHECKED
APPRVD
DATE
27-9-48
5000Ω SPKR. XFMR.
7C5
7C6
7A7
7A8
6X5GT
TONE CONTROL
VOLUME CONT. 500K
RADIO-GRAM SWITCH
I6 460KC
I5
I4 460 KC
I3
I2
I1
T1
T2
T3
PADDER
AERIAL
PICKUP
SWITCH ON VOL CONTROL
230V AC
6·3V PILOTS & HEATERS
240V
230V
350Ω
15V
105V
3·1V
25K
10M
1M
20K
50Ω
200Ω
10K
390
1000

The PHILIPS Experimenter

No. 28: (a) CONSTRUCTION OF THE POWER SUPPLY UNIT (b) AERIAL FEED AND MATCHING

CONSTRUCTION OF THE POWER SUPPLY UNIT

The last two instalments of the Experimenter have been spent in describing the circuits and adjustment of the power supply system for the whole Philips transmitter, together with the interlocking protective relay system, which is an integral part of the power arrangements. Before leaving the power supplies, however, it will be as well to present some photographs of the completed unit and say a little about its construction.

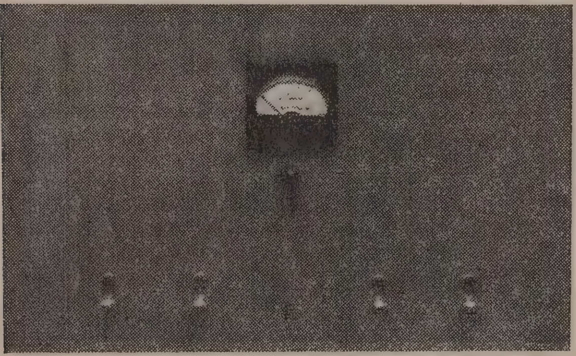


Fig. 3.—Front panel view

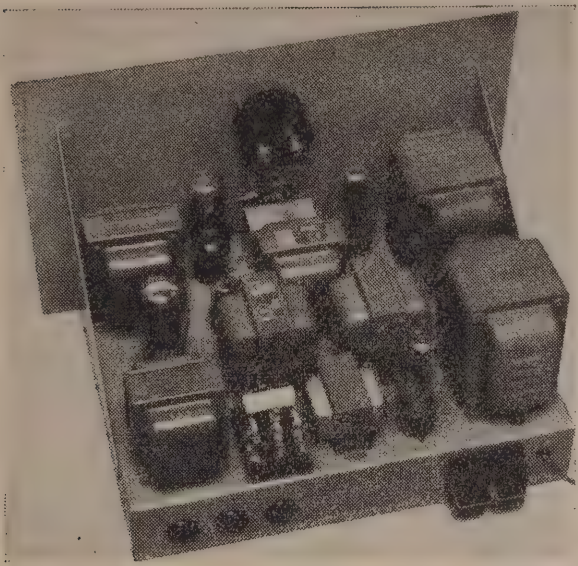
Of course, the construction is very straightforward, and holds no difficulties for the experienced constructor other than those associated with ensuring that the rather complicated system of inter-chassis wiring does not get out of hand. We would like to emphasize at this point that, when the supplies are wired up and connected to their respective sockets on the back of the supply chassis, it is not only advisable but almost essential to draw an under-socket view of the connections, making quite sure that the actual wiring agrees with the drawing. If any mistakes are made here, they can lead to disastrous consequences when the exciter final and modulator are connected up. Also, from the personal safety point of view we would urge readers especially NOT to switch anything on until all the chassis are mounted on the rack **and are solidly bonded both to each other and to earth.** With the circuit arrangement given, this precaution is even more important than usual, because of the way in which several of the power supply circuits are broken at their transformer centre-taps while the rest of the supply, including the rectifier, is on. It is not that there is anything inherently dangerous about this sort of arrangement, but if any mistakes have been made in the wiring—and these are remarkably easy—it is quite possible for one chassis to become "live" if all are not bonded together and earthed. It should be remembered, too, that if a power supply circuit is "off" only because the transformer centre-tap is disconnected from earth, it is possible to get the father of all shocks by inadvertently touching the centre-tap circuit. We know, because, while the unit was under construction, the writer fell into this very trap. As it was, all he got was a severe nip, but things might easily have been more serious.

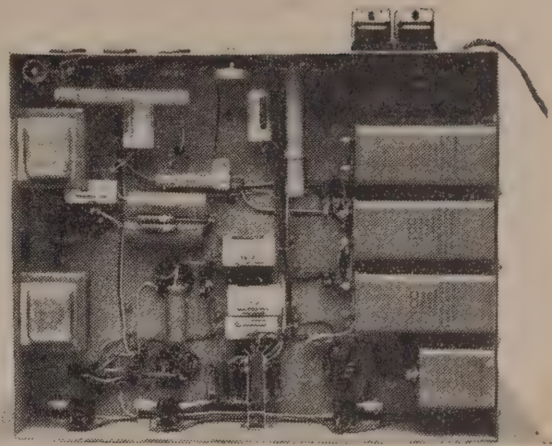
With these words of warning, perhaps we can now have a look at the photographs on this and the next page. The front panel, as might be expected, is quite simple in appearance, containing as it does, only the voltmeter and its range switch and the lower row of power switches and their attendant indicator lights.

The back view gives a good idea of the general arrangement, and intending builders would do well to examine it in conjunction with the chassis drawing printed in Experimenter No. 26. At the right are the two 500-a-side power transformers for the final and modulator plate supplies. Next to them, one at the back and one at the front, are the two AX50 mercury-vapour rectifiers belonging to these transformers. Grouped in the centre of the chassis are the three large smoothing chokes, one for the final supply and the other two for the modulator supply. On the left (in the photograph) are the two remaining transformers. The one in the back corner is that of the modulator screen supply, while the other is, of course, the exciter transformer. The rectifiers associated with these transformers are mounted close to them, but the chokes are not all in evidence, as one of each pair is mounted under the chassis. One of the 80 ma. chokes is at the front of the chassis, right under the meter and its switch, which can be seen quite clearly in the photograph. The EL35 grid bias rectifier for the modulators can just be glimpsed between the exciter's power transformer (from which it is fed) and the bunch of large chokes in the middle of the chassis.

The relay to be seen at the back of the chassis is the overload relay. The final's cathode relay and grid current relay are both on the final chassis. On the left-hand end are the three octal sockets carrying the output of the power supplies and also the modulator bias-adjusting potentiometer. On the other end of the back of the chassis are two double fuse-holders, accommodating the four fuses. Incidentally, one should remember that the overload relay carries 600 volts on its contacts, and should be respected accordingly. Strictly speaking, it should be covered in after final adjustment.

Looking now at the under-chassis view, we can see most of the main components not visible in the top view. Along one side of the chassis are mounted the can-type oil-filled high-voltage condensers. These are directly underneath the high-voltage transformers to which they belong. On the other side are the remaining two small filter chokes. In the centre of the chassis front can be seen the overload reset switch. This is of the self-returning push type, with leaf contacts like a telephone relay. These switches are available from war-surplus stock, and have two change-over sets of contacts. The inner ones are normally closed, and are the ones used. It was found, when the circuit was originally wired up, that the rather heavy current through the dummy load was too much for one of the contacts by itself to open without an arc developing. It was thought that a different type of switch would have to be used, until we tried wiring the two normally closed pairs of contacts in series, so that when the re-set button was pressed there were two gaps instead of one. This worked perfectly, and no further arcing was experienced.





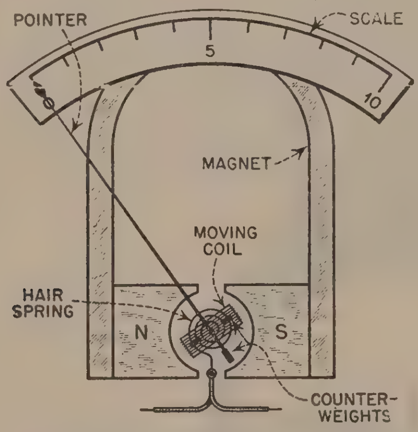
Left: Fig. 2.—Looking into the power supply unit from above.

Above: Fig. 1.—Underneath view.

THE DIRECT-CURRENT METER

By The Engineering Department AEROVOX CORP.

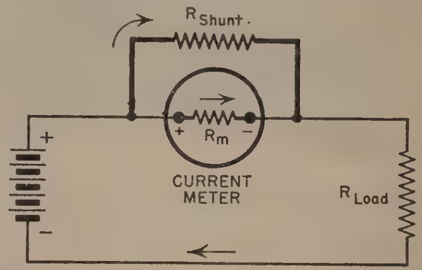
Although the D.C. meter is a standard tool around the laboratory, service bench, or "ham shack," its usefulness may be greatly enhanced by a better understanding of the principles underlying its construction and applications. Despite the fact that the judicious use of electrical instruments is an unfailing hallmark of the skilled electronics technician, there is a tendency on the part of many to accept the meter at its face value without ever gaining an intimate knowledge of its internal functioning. Actually, a complete familiarity with the capabilities and limitations of the D.C. meter can be gained only through a study of its electrical and mechanical characteristics. This paper will discuss these characteristics and point out certain precautions to be observed in the use of such measuring instruments. Because the moving-coil, permanent-magnet type known as the D'Arsonval meter forms the basis of about 90 per cent. of the meters in common use, being used to measure current, voltage, and resistance with different auxiliary circuitry, the present discussion will be restricted to this type.



ESSENTIAL PARTS OF D.C. METER
FIG. 1

THE D'ARSONVAL MOVEMENT

The fundamental principle of all general types of electrical meters is the same; the electrical quantity to be measured is converted into a mechanical motion which is calibrated in terms of that electrical quantity by means of a scale and pointer. In the D'Arsonval type, direct current flowing in the turns of a coil suspended in a steady magnetic field produces an electromotive force which rotates the armature against the counter-torque of a hair—by an amount proportional to the current flowing. A light pointer attached to the armature indicates the rotation of the coil, and therefore the current value, on a semi-circular calibrated scale. Fig. 1 illustrates the usual form of this arrangement. The current-carrying coil is wound on a lightweight frame or armature which, in turn, is supported between sapphire-jewelled pivot bearings which allow it to rotate freely. The electrical connections to the coil are made through spiral hair-springs at each end of the armature. These fine alloy springs perform several vital functions. Besides providing the current-carrying path between the armature and the stationary parts of the meter, they provide the counter-force against which the meter torque or rotational force acts, as well as supplying the restorative force which returns the pointer to zero when current ceases to flow. The coil thus mounted is immersed in a strong magnetic field which is usually provided by a permanent magnet. The stability and permanency of this magnet are of importance, as well as the uniformity of the magnetic field produced between its poles. The pole tips are usually semi-circular in shape to fit closely round the moving



$$R_{Shunt} = \frac{R_m}{(N-1)}$$

R_m = Internal meter resistance.
N = Desired scale multiplying factor.

USE OF SHUNT RESISTANCE TO EXTEND CURRENT-METER RANGE
FIG. 2

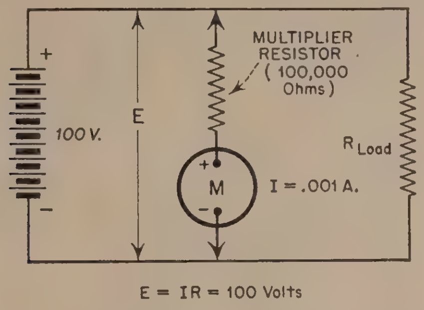
coil. The uniformity of field is greatly improved by the use of a cylindrical core of soft iron mounted in the centre of the armature so that the moving coil revolves round it. The indicating pointer is affixed to the armature at one end and a system of small adjustable counterweights is used on the tail-piece and cross-arm of the pointer to balance the complete armature assembly. The angular movement of the moving coil assembly is restricted by a set of cushioned stops.

The completed assembly is extremely delicate and precise. It is interesting to note that most of the components serve several purposes. For instance, the armature frame not only provides the form upon which the current-carrying coil is supported, but is also a closed-loop conductor in which eddy currents are induced which oppose the motion of the armature and so provide **damping** of the meter movement. Excessive over-swing or oscillation of the pointer is thus avoided.

THE CURRENT METER

Essentially, the D'Arsonval meter is a current measuring device. The flow of current through the moving coil sets up a magnetic field round the coil which interacts with the fixed field produced by the permanent magnet to cause rotation of the coil. The turning torque developed is proportional to the strength of the permanent magnet, the number of

turns in the coil, and the amount of current flowing in the coil. The pointer deflection which results is determined by the strength or counter-torque of the spiral springs. At any given meter deflection, the torque produced by the interaction of the current in the coil and the magnetic field is exactly equal to the counter-torque of the hair springs, and an equilibrium results. Since in any given meter design the current in the coil is the only variable, the deflection of the pointer is directly proportional to the amount of current flowing. The scale gradations in properly designed D.C. meters of this type are therefore linear.



USE OF D.C. METER AS VOLTMETER

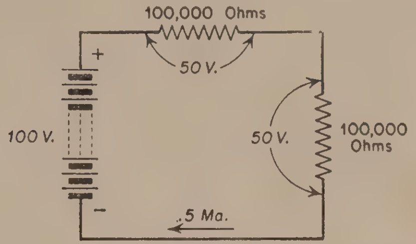
FIG. 3

The amount of direct current required to deflect the pointer to the highest gradation on the scale is called the **full-scale sensitivity** of the meter. Instruments are manufactured in a wide range of sensitivities ranging from amperes down to a practical limit of about 20 microamperes. In addition to the above, high-sensitivity instruments are available with sensitivities of 1 microampere for full-scale deflection. Such high sensitivities are achieved by the use of powerful permanent magnets, lightweight multi-turn coils, and very delicate hairsprings.

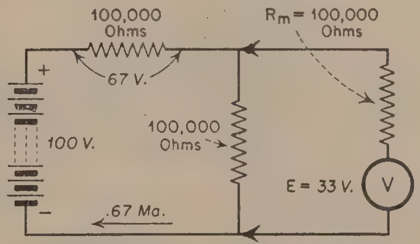
Meters having sensitivities of one milliampere or less may be used for measuring any larger value of current by the proper use of **shunts.** If a conductor having a resistance equal to the internal resistance of the meter is connected in parallel with it, the current will divide equally between the two paths and hence twice as much current will be required to give full-scale deflection of the meter. If a shunt is chosen which has one-fourth the resistance of the meter coil, the currents through the parallel resistances divide in the ratio of 4 to 1, and since only **one-fifth** of the total current flows through the meter, its full-scale indication is multiplied by a factor of 5. Fig. 2 shows the connection of a shunt to a direct-current meter and the equation commonly used to determine the shunt resistance required to extend the scale by a factor of N. The internal resistance of the meter may be determined from the published characteristics of that type, or by measurement. In multi-range instruments it is usual to select shunts which multiply the scale calibration by multiples of 10 for ease in reading.

THE D.C. VOLTMETER

The same basic movement which is used to measure direct current is also employed in voltmeters. In this case, resistance is added **in series** with the meter in the manner shown in Fig. 3. Such external **multiplier resistors** may be used with a high-sensitivity milliameter or microameter to measure voltages ranging from millivolts to kilovolts. The meter is still performing its original function as a current-measuring instrument, but in this case it is measuring the current which an unknown voltage causes to flow in a known resistance. The voltage is therefore determined by Ohm's Law ($E = IR$), and the meter scale may be calibrated directly in terms of voltage. Meters for voltmeter applications are classified according to "ohms-per-volt" ratings—i.e., the number of ohms which must be contained in the voltmeter circuit for each volt which the meter is to indicate. For example, to limit a voltmeter using a one-milliampere basic movement to full-scale deflection when 10 volts is impressed, the total resistance of the circuit must equal 10,000 ohms, by Ohm's Law. A total of 15,000 ohms would be required for 15 volts full scale, etc. Thus a 0.001 ampere meter one milliampere full



UNDISTURBED CIRCUIT CONDITIONS



CIRCUIT "LOADED" BY VOLTMETER

FIG. 4

scale is rated at "1000 ohms-per-volt." The same meter can be made to read 500 volts full scale by using a 500,000-ohm multiplier in series with it. In such cases, where the required multiplier resistance is very large compared with the internal meter resistance, the latter is usually ignored, since the error introduced is much less than the reading accuracy of the meter. However, if it were desired to make a 1000 ohms-per-volt meter read 1 volt full scale, it would be necessary to include the meter resistance in the total value of 1000 ohms required. If the internal resistance of the meter is 100 ohms, the correct value of the multiplier would be 900 ohms, since a 10 per cent. error would be introduced if the meter resistance were neglected.

Since the voltmeter is always connected across the voltage drop being measured, it is important to use an instrument having a total resistance which is large compared to the circuit to which it is connected. Otherwise, serious inaccuracies result, since a low-resistance meter "loads" the circuit being measured so that the voltage drops indicated are not those which exist in the undisturbed circuit. A simplified

example of such misuse of the voltmeter is illustrated in Fig. 4. To reduce such errors, basic meters having full-scale sensitivities of 50 microamperes (20 000 ohms-volt) or 100 microamperes (10,000 ohms-volt) are used in high-quality voltmeters.

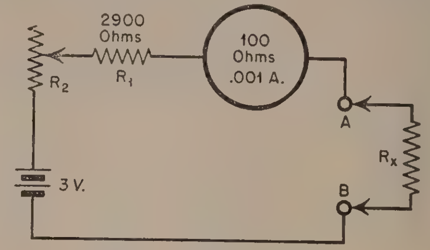
THE OHMMETER

Just as the D'Arsonval current meter is used to determine voltage when the current and resistance are known, it may be used equally well to read resistance by indicating the current which flows when a known voltage is impressed across an unknown value of resistance.

Such an instrument calibrated directly in ohms, is called an "ohmmeter," and is widely used in a variety of circuit types of which Fig. 5 is a typical example. In this circuit, a battery or other source of voltage is provided which is capable of producing a full-scale deflection on the meter when the test terminals (A and B in Fig. 5) are shorted. Variations in battery voltage and other circuit constants are compensated for by adjustment of a rheostat (R2). If an unknown resistance is inserted between the test terminals, the meter deflection will be reduced proportionately. The meter scale can, therefore, be calibrated directly in terms of the external resistance required to limit the meter current to that value. When the unknown resistance is equal to the internal resistance of the ohmmeter circuit, the meter will read half-scale. The formula used for the calibration of this simple ohmmeter type is also shown in Fig. 5. For the measurement of extremely low or high value of resistance, more complex ohmmeter circuits are employed.

METER ACCURACY

Direct current meters are supplied in many degrees of accuracy according to the requirements of the application. Such applications vary extremely from meters for use as primary laboratory standards having rated accuracies of 0.1 of 1 per cent. to mere indicators of the presence or absence of electricity.



$$R_x = R_c \left(\frac{I_s - I_x}{I_x} \right)$$

Where:

R_x = Unknown resistance.

R_c = Circuit resistance (A and B shorted).

I_s = Meter current (A and B shorted).

I_x = Meter current (R_x in circuit).

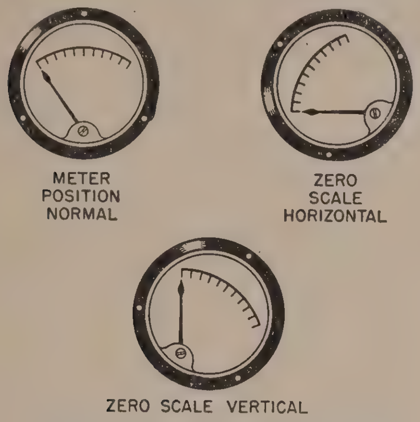
TYPICAL OHMMETER CIRCUIT
FIG. 5

Meters rated at better than 1 per cent. accuracy fall into the "precision laboratory" category, and should be used only in protected, "well behaved" circuits requiring such high accuracy. They are usually of the "portable" type which are used with the needle in a horizontal position for greater accuracy and have mirror-scales to reduce parallax errors in reading.

In the accuracy range below 1 per cent. are the great majority of 'general utility" or 'panel" meters which are the "work horses" of the electrical instrument family. They are usually mounted in test equipment panels and switchboards in a vertical position. The average accuracy of this class of meters is about 2 per cent.

The accuracy rating of all D.C. meter types is

usually given in terms of the percentage of full-scale reading to which the meter is guaranteed. A single range meter reading 100 volts full scale and rated at 1 per cent. accuracy would thus read within 1 volt of the correct value of any deflection. At 10 volts this meter could, therefore, be in error by as much as 1 volt, or 10 per cent. Good engineering practice dictates that meters be used at a minimum of one-third full-scale deflection for this and other reasons.



TEST FOR MOVEMENT BALANCE

FIG. 6

FACTORS AFFECTING METER ACCURACY

The manufacturers' nominal accuracy rating does not ensure accurate results from a meter in the hands of an inexperienced technician or an instrument which has been subjected to abuse. The following tabulates some of the mechanical and operational factors which may cause large errors in the reading of D.C. meters of the D'Arsonval type:—

(a) Stray Magnetic Field Errors.—Since the deflection of the meter depends on the strength of the permanent magnet, serious errors may be introduced by stray magnetic fields from other meters, current carrying conductors, magnets, and other ferrous materials. Expensive meters are usually provided with adequate magnetic shielding. Some errors are also caused by mounting small meters in heavy steel panels. Meters specially calibrated for such mounting are usually so marked.

(b) Balance Errors.—The delicate system of counterweights which balance the moving-coil assembly may cause "zeroing" or reading errors if improperly adjusted. The balance of the movement may be checked by holding the meter in the three positions shown in Fig. 6. If the pointer does not indicate zero in each position, the movement is not perfectly balanced. Unbalance is most serious in vertical mounted meters.

(c) Overload Errors.—Permanent damage or burnout may be caused by repeated or heavy overloads of the meter movement. Excessive current through moving-coil types causes heating of the coil and springs. Heating of the latter results in "annealing" or loss of spring tension, which impairs accuracy. Overloads also cause needle "banging," which may damage pointer or pivots.

(d) Sticky Movement Errors.—The meter movement may be prevented from moving freely by several mechanical defects. Chief among these is chipped jewels or damaged pivots due to rough handling. Sticking may be manifest in the failure of the meter to reproduce a known reading when approached from values above and below the known value. Light tapping of the meter case is frequently resorted to as a cure. Meter sticking is also caused by small magnetic particles which may be gathered by the magnet of a meter which is removed from its case and left unprotected.

OUR GOSSIP COLUMN

MANUFACTURERS' PRESIDENT ON OVERSEAS VISIT

Mr. Wm. J. Blackwell, President of the New Zealand Radio Manufacturers' Federation, and Managing Director of the Swan Electric Company, left Auckland on 13th January by flying-boat for Sydney to connect with the Pan American Airways service en route to Honolulu for consultations with his American co-director and other associates. The Honolulu conference will be followed by a visit to Los Angeles where the Swan Company has business interests. Mr. Blackwell, while on the American west coast, will take the opportunity of surveying the general American trade picture and in particular trends in the radio, television, and general electronic fields in relation to his own organization and the New Zealand Federation and industry as a whole.

During the President's absence from the Dominion, Mr. P. C. Collier, Vice-President, will hold the Federation reins.

* * *

On the eve of his retirement from business and departure for Australia, Mr. C. W. Rickard was the guest of honour at a large gathering of friends and business representatives. Mr. Charles Odlin, who presided, in presenting Mr. Rickard with a cheque from the C. & A. Odlin Timber & Hardware Co., Ltd., referred in moving terms to the esteem in which Mr. Rickard was regarded by all members of his company. Many other tokens of goodwill, including a wristlet watch, binoculars, radio set, and travelling rugs, were presented to Mr. Rickard from his associates.

* * *

During the holiday period, the New Zealand Model Aircraft Association held their national competition meeting at Rukuhia Aerodrome, and a feature of the meeting was a demonstration by Mr. L. H. Wright of his radio-controlled sailplane, a photograph of which appeared on the cover of our December, 1949, issue. The demonstration was a great success until one of the local amateurs, hearing signals on the 6-metre band, started calling CQ, whereupon the model proceeded to answer these unofficial control signals. The peculiar behaviour of the plane was something of a mystery until, while checking on the ground, Mr. Wright found that speech was issuing from the innards of the kite! This, of course, was due to the relay winding "talking."

The occurrence brings up a question that was bound to arise sooner or later—namely, whether special frequencies, outside the amateur transmitting bands, cannot be allotted for model control work, as is the case in the United Kingdom.

At any rate, the demonstration was a huge success and created a great deal of interest, not only among the model aircraft enthusiasts, but also among the Hamilton amateur transmitters, many of whom, Mr. Wright, tells us, moved off at high speed to commence building models to control!

* * *

Our sympathies are extended to Electronic Navigation and Nameplates, Ltd., Auckland, on their loss in the disastrous fire which spread through their premises at Nagel House on 19th January.

* * *

Just prior to the Christmas holidays, many friends gathered in the laboratory of "Radio and Electronics" for a "convivial," Doug Foster being the host and Alex Ayton looking after the wants of the inner man, while Charles Roser did his best to keep that hefty block of "tasty" cheese from "walking."

* * *

Visitors to Wellington during January included Vic Barton and Gordon King, Auckland and Christchurch managers respectively of Arnold & Wright, Ltd., and Brian Terry and Allen Rayner, of Grover Electric Co., Ltd. The two latter gentlemen attended the Grover New Year sales conference.

* * *

On returning to Waipukurau, the old "home town," Keith Alexander has relinquished his position as town traveller for the Swan Electric Co., Ltd., while the call of the sea has again proved too strong for Ron Glen, of the same firm, who has forsaken country travelling for the life of a radio operator on the high seas. "Radio and Electronics" wish these two old friends every success in their different spheres.

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Gordon Ward, late of Radio Corporation, is now established in his own business at The Mount, Tauranga.

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Another enthusiast branching out on his own in Auckland is E. B. Menzies, late of Johns, Ltd.

A PRACTICAL BEGINNERS' COURSE

PART 39: THE TWO-VALVE SPEAKER-WORKING BATTERY SET (Continued)

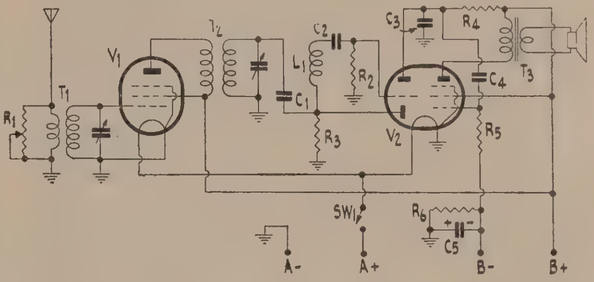
Last month we were pointing out some of the difficulties of ganging two tuned circuits together so that they could be tuned with the one control knob, as is done in all modern commercially-made sets. Although the coils can easily be made identical, for all practical purposes, and also the sections of ganged condensers, this does not necessarily mean that when a set is wired up using such coils and condensers, both tuned circuits will tune to exactly identical frequencies at all settings of the dial. If the set is to work as well at one spot as on another—and it must if it is to be at all efficient—the two ganged circuits MUST track accurately. If they do not, under the circumstances we have described, it can be due only to one cause. This is that the unavoidable "stray" capacities, such as those of the valves themselves, and of the wires used to connect the coils, condensers, and valves together, are not equal in the two tuned circuits.

It might appear, then, that we have set ourselves a problem that is incapable of solution, but, luckily, such is not the case. We resort to a very simple but effective dodge, which, if the coils and condensers are really similar, as they should be, works just as we want. This dodge consists of adding two small adjustable condensers to the circuit, one each in parallel with each coil and condenser. In many cases, these "trimmer condensers," as they are called, are made part of the gang condenser, and are built into it. If built-in trimmers are not part of the gang condenser, then small adjustable condensers are sold for the purpose, and must be wired into the circuit separately. It will be noted that the circuit diagram of the set does not show these trimmers at all, nor does it show that the tuning condensers are "ganged." We have omitted both these features purposely, because quite often they are left to the imagination of those reading the circuit. However, there is no difficulty in recognizing the tuning condensers on the circuit, because these are the only two variable condensers. The method used for indicating ganged variable condensers is to extend the arrow downward, by means of a dotted line, and then to draw a horizontal dotted line to join the two and to indicate that both move together.

HOW THE TRIMMERS WORK

How is it, then, that these trimmers manage to make the two tuned circuits track accurately over the whole dial? Let us suppose that we have a capacity when fully meshed of 420 $\mu\mu$f.—a stock value—and a capacity, when fully unmeshed, of 15 $\mu\mu$f. Suppose, further, that the "stray" capacities associated with the grid circuit of V_1 amount to 10 $\mu\mu$f., and that the strays belonging to the second tuned circuit are only 5 $\mu\mu$f. This means that the total circuit capacity will be 25 $\mu\mu$f. for the aerial circuit and 20 $\mu\mu$f. for the detector circuit when the ganged condensers are right out. The difference is only 5 $\mu\mu$f., but the **percentage difference,** which is what really matters, is 20 per cent. This is quite large enough to cause the circuits to tune to widely different frequencies when the condensers are out. At the low-frequency end of the dial, however, the difference is still 5 $\mu\mu$f., but the percentage difference is only a little more than 1 per cent., which would be quite unnoticeable in a set like this. Thus, the set would perform well at the end of the dial where the condensers are fully meshed, but would get progressively worse as we moved towards the high-frequency end. The noticeable result would be that at the low-frequency end, the performance and sensitivity would be very good, but at the high-frequency end the sensitivity would be very poor.

Now, the adjustable condensers used as trimmers have a capacity that can be varied between 3 and 30 $\mu\mu$f. Thus, if we place one of these in parallel with



V_1, 1N5.	C_1, 50 $\mu\mu$f.
V_2, 1D8-GT.	C_2, 0.002 μf.
R_1, 10,000 ohm pot.	C_3, 0.0005 μf.
R_2, 10 megs.	C_4, 0.05 μf.
R_3, 1 meg.	C_5, 25 μf. electrolytic.
R_4, 100k.	T_1, aerial coil.
R_5, 1 meg.	T_2, R.F. coil.
R_6, 1000 ohms.	T_3, output transformer.

each tuned circuit, it will be possible to make the minimum circuit capacity in each equal to 28 $\mu\mu$f. To see how this comes about, let us imagine that one trimmer, the one connected to the aerial circuit, is set at its smallest capacity of 3 $\mu\mu$f. This will make the minimum capacity in the aerial circuit equal to 28 $\mu\mu$f—15 for the gang condenser section, 10 for the stray capacities, and 3 for the trimmer. Now, the detector circuit has a minimum, without the trimmer, of 20 $\mu\mu$f., so that, if we have some means of setting the detector trimmer at a capacity of 8 $\mu\mu$f., then both circuits will have the same minimum capacity of 28 $\mu\mu$f. Now, remembering that the coils are absolutely identical, the two tuned circuits must tune to exactly the same frequency when the gang condenser is fully out of mesh. The circuits are now said to be **aligned,** or **lined up,** at the high-frequency end of the dial.

The question now arises, of course, whether, after we have messed about with the minimum capacity in this way, the circuits will still track at the low-frequency end of the broadcast band. A little further arithmetic will show that what we have done to obtain perfect alignment at the high end has not affected the tracking at the low end at all. We have given each circuit a minimum capacity of 28 $\mu\mu$f. Now, the gang condenser sections are identical, and each adds a capacity of $420 - 15 = 405$ $\mu\mu$f. to its own circuit when fully meshed. Thus, each circuit has a maximum capacity of 433 $\mu\mu$f. And, since the coils are still the same, the circuit must be tuned

to the same frequency, and the set is still aligned properly, not only at the full-in position of the condenser, but also at all intermediate positions, because, however one turns the dial, each section of the gang has the same capacity.

This might seem a long-winded description of a simple matter, but it is as well to have a clear idea of what operations like trimming, or aligning, actually mean. Then, when we come to do them in practice, we can save ourselves a great deal of time which might otherwise be spent in unprofitable fiddling.

From the description, it might seem to some that, even if we put trimmer condensers into the circuit, we have no means of adjusting them accurately to within a micro-micro-farad, as the argument suggests we can. Fortunately, there is a very easy method of trimming the circuits, which is quite accurate and which does not involve making measurements of just how much minimum capacity we have in practice. Luckily, we are not very interested in knowing accurately just what the capacity of the circuits is, but only in whether or not the minimum capacities are equal. To do this, we rely on the simple and obvious fact that if both tuned circuits are tuned to exactly the same frequency, the result will be a much louder signal from the set than if they are on different frequencies. Thus, to align the set, all we have to do is to pick up a station at or near the high-frequency end of the broadcast band, set one trimmer to about half-capacity, and then turn the other until the signal is loudest. Then, if the coils and the sections of the gang condenser are well matched, as they should be if the makers have done their job properly, the set will be properly aligned and will need no further adjustment.

We have made quite a song and dance about this alignment business, because it is most important, not only for this set, but because it is an important part of the building of all modern sets whose tuning is done by a single control-knob.

CIRCUIT OF THE REST OF THE SET

After dealing with the tuned R.F. amplifier stage, or T.R.F. stage as it is often called for short, it will be found that there is nothing very new about the rest of the set. This might look a little complicated, because the 1D8-GT is really three valves in one, as has already been mentioned, but the circuit is just the same as it would be if three separate valves were used instead, with the exception that here we have only one filament to wire up as against three if the separate valves are used. L_1 on the diagram is an R.F. choke, and its purpose is to block the R.F. voltages which appear at the detector diode from being applied to the grid of the audio amplifier section of the valve. Many howls and squeals are due to R.F. voltages getting in where they are certainly not wanted—namely, into the circuits of audio amplifiers. C_3 is known as the blocking condenser because its purpose is to block off from the grid of the audio amplifier valve the D.C. voltage which also appears at the plate of the detector diode. R_3 is the grid leak for the audio valve, and is needed because here we have no transformer winding to make a through connection to earth for the grid. This is a point we have not previously mentioned. If the grid of a valve, whether R.F. or audio amplifier, has no connection back to the filament or cathode, then electrons become trapped on the grid and build up a voltage on it, which in many cases will prevent it from working as an amplifier at all. You will remember when we had a transformer-coupled audio amplifier stage, the secondary winding of the transformer was connected between the grid of the valve and earth. This makes the connection back to the filament for the grid, a connection which is usually called the **grid return circuit**, because it allows any electrons that may be collected by the grid to flow round the D.C. grid circuit and **return** to the filament or cathode.

In this circuit we have no transformer winding to act as the grid return circuit, and we have interposed a blocking condenser between R_3 and the grid. Thus, unless R_2 were present, the valve would have what is called an **open** grid circuit, and blocking would occur. Someone may well ask at this point why we put in C_1 anyway, because, if it were omitted, there would be a grid return path through R_3. So there would, but the amplifier valve would still not work properly. The reason for this is that when the detector receives a signal, a D.C. voltage is developed across the resistor, R_3, and if C_1 were not there this voltage, in negative polarity, would be applied directly to the grid of the amplifier valve.

Unfortunately, although a certain amount of negative bias is necessary for an amplifier valve, the amount obtained from the detector would vary according to the strength of the signal, so that at times it would be too great and at other times it would be too small for proper operation of the amplifier. The best scheme is, therefore, to block this voltage altogether and to provide a grid leak, R_2. In a resistance-coupled amplifier stage, we do not have the primary winding of an audio transformer in the plate, but, instead, a plain resistor of quite a high value. At the plate of the valve there then appears an amplified version of the signal applied to the grid. The plate, however, is at quite a high positive voltage—not quite so high as the B battery voltage, but high enough to make it impossible to connect the grid of the next valve directly to the plate. Thus we put in another blocking condenser which, as ever, allows the alternating signal voltages to pass freely, but blocks the direct voltage. This condenser is C_4 on the diagram. The final amplifier stage, which is also a part of the 1D8-GT, is a pentode, and is used to supply power to work the loudspeaker. The idea of a **power** amplifier, as distinct from a **voltage** amplifier, is a new one to readers of this course, and we will have to postpone a discussion of it until the next issue.

TELEVISION TRENDS IN THE DOMINION

STATEMENT MADE BY MR. WM. J. BLACKWELL, PRESIDENT OF THE NEW ZEALAND RADIO MANUFACTURERS' FEDERATION

"An indication of the material difficulties at present in the way of establishing a television service in New Zealand was given by Mr. Wm. J. Blackwell, President of the New Zealand Radio Manufacturers' Federation, on the eve of his departure overseas last week," said the Federation Acting President, Mr. P. C. Collier, recently. "The difficulties are very real—not insurmountable, but in view of the general infancy of this new art, and the lack of stability in international standards, as well as the imminence of colour transmissions, the New Zealand administration should be commended for its caution in determining a policy that could conceivably be inimical to the best interests of the viewing public.

"New Zealand radio manufacturers have always been in the van of technological developments in radio engineering, and have been quick to follow and develop worthwhile overseas trends," continued Mr. Collier. "This fact is amply evidenced in the range and quality of New Zealand-made sound broadcast receivers on the Dominion market at the present time, which are universally acknowledged to be the equal of overseas products—in fact, superior in many cases. In this regard New Zealand listeners are indeed fortunate in that New Zealand-made receiving sets, according to price, fairly complement the high quality transmissions maintained throughout our broadcasting stations, which are of the most modern design, and maintained to the highest technical standards. Contrary to popular belief, these high standards of transmission and reception are not the rule in overseas countries, as witness the many justifiable criticisms levelled at the British Broadcasting Corporation, the sole provider of broadcasting programmes in Great Britain.

"Television is a natural and most heartily sought extension of the industry's activities, and when a service is mooted, manufacturers will be well ahead of demand with sets employing the latest scientific advances in this new field," Mr. Collier said. "Concentrations of population, distances separating such concentrations, and terrain characteristics are important factors when considering establishment of a full coverage service in any country. These points are well exemplified in the present state of development in Britain, which until a few weeks ago had one station only serving the Greater London area, or covering a radius of approximately 40–50 miles. An additional transmitter has recently been established at Birmingham, and together these stations, within their narrow boundaries of 40–50 miles, should cater for a potential audience of perhaps 10,000,000. By contrast, the same stations in New Zealand, with the same boundary limitations, would serve some 40,000 viewers in the more idealized locations of Wellington and Auckland. It is not difficult to appreciate the significance of the foregoing in the matter of cost of stations, preparation and maintenance of programmes, etc., as applied to New Zealand conditions at large."

Progress in recording techniques would eventually simplify the maintenance of low-cost programmes, and likewise equipment standardization and simplification would lower costs of transmitting stations to the point that the plurality of stations needed to provide for the majority of New Zealand's radio audience would be an economic possibility.

"The inference of a recent English visitor that New Zealand development in television is bogged down through disinterest or lethargy of the New Zealand radio manufacturing industry is strongly refuted," said Mr. Collier. "Similarly, the suggestion that 'Home' manufacturers have waiting capacity and finance to erect stations throughout New Zealand for the doubtful privilege of operating them is seriously questioned. There is far greater scope for such opportunism in the 'Home' countries themselves with some precedent for more urgent consideration.

"In the long run, any public service must be borne by the people. The New Zealand Radio Manufacturers' Federation, notwithstanding its natural commercial interest in early television development in New Zealand, is at one with the broadcasting authorities in New Zealand and in our sister Dominion, the Commonwealth of Australia, in their determination to assess all relevant facts, so that a fully up-to-date and permanent service may be instituted for the benefit of all the people at a nominal cost to the viewer," Mr. Collier concluded.

The *Radio and Electronics* Abstract Service

AUDIO EQUIPMENT AND DESIGN:

Williamson Amplifier. New version. Values of R23 and R24, Fig. 1 (p. 282, W.W., Aug., 1949) omitted from article. Values are each 100 ohms, ½ watt, plus or minus 20 per cent.
—**Wireless World (Eng.), September, 1949, p. 328.**

Loudspeaker Enclosures. Review of the principles involved in selecting loudspeaker enclosures for various applications. Practical data regarding flat baffles, vented cabinets, and corner cabinets.—**Radio News (U.S.A.), November, 1949, p. 35.**

High-quality Amplifier Design. Outline of simple tests for determining forms of distortion in audio amplifiers. Circuits of two-frequency audio signal generator; high-quality amplifier with p.p. 6L6 valves, 20 watts output.
—**Radio News (U.S.A.), November, 1949, p. 39.**

A Modern Wide-range Phono Amplifier. Circuit and construction of an amplifier which incorporates simplified dynamic noise-suppressor and bass and treble control circuits. 6AS7 (dual triode) valve in p.p. 10-watt output. All-triode amplifying stages.—**Radio News (U.S.A.), November, 1949, p. 46.**

An Intercom. for the Home. Circuit and construction of system which has three master stations, two sub-stations, and one amplifier. Provision made for listening, on the master stations, to programmes from the home receiver. Amplifier is three-stage, high gain, with maximum output of 3 watts.
—**Radio News (U.S.A.), November, 1949, p. 49.**

A Horn-type Transducer of Minimum Dimensions. Full constructional details of a simplified horn with straight sides, and a description of a more complicated model with tapered sides.
—**Radio News (U.S.A.), November, 1949, p. 54.**

A Direct-coupled Amplifier with Cathode Follower. Circuit and construction of an audio amplifier employing 6V6 cathode-follower output, directly coupled to which is 6SJ7 stage. D.C. resistance of primary of output transformer must be 250 ohms in order that 6V6 may have correct bias applied. High fidelity and distortionless output claimed.
—**Radio News (U.S.A.), November, 1949, p. 62.**

Fixed Bias for Audio Output Stages. Analysis of various circuits which provide fixed bias for triode and pentode output stages.—**Radio News (U.S.A.), November, 1949, p. 80.**

ANTENNAE AND TRANSMISSION LINES:

Two-band Antenna Matching Networks. Design formula for all practical cases of antenna working on two harmonically-related amateur bands.—**QST (U.S.A.), October, 1949, p. 14.**

CIRCUITS AND CIRCUIT ELEMENTS:

Asymmetrical Multivibrators. Mathematical analysis of waveform of pentode valves in an unsymmetrical multivibrator circuit. Simple formulae may be used for computing frequency and waveform when one of the two anode voltages is rectangular, or nearly so, and multivibrator is in steady state.
—**Wireless Engineer (Eng.), October, 1949, p. 325.**

Push-pull A.F. Amplifiers. Discussion of problems of position of composite load-line and construction of valve load curves for classes A, B, and C p.p. A.F. amplifiers. Investigation into method whereby asymmetrical operation of p.p. valves in any combination of Class A, B, or C condition can be represented on IaVa curves; into possible relationship between the operating direct currents of each valve and the steady anode voltages, and into relative importance of the operating direct anode current values and the quiescent D.C. values. Photographs reproduced of valve-load curves obtained on C.R.T.
—**Wireless Engineer (Eng.), October, 1949, p. 338.**

Electronic Circuitry. (1) R.C. oscillators; important details of design clarified. (2) Cathode-coupled amplifiers; variable gain. Best restricted to p.p. stages when exact balance important. When gain varied between narrow limits, a fair approximation to balance possible with phase-splitter circuit.
—**Wireless World (Eng.), September, 1949, p. 346.**

Stabilized Voltage Dropping Element. Use described of cathode-follower to give adjustable, stabilized D.C. voltage with small bleeder current. Valves used may be 6J5 or 6SN7 (triodes in parallel) for heavier current. One application of circuit is for

regulation of screen voltage supply for beam amplifier valves in Class AB.
—**Radio News (U.S.A., Rad. El. Ed.), Nov., 1949, p. 6.**
Adjustment of Quadrature Networks. Design and circuit of precision 90-degree phase shifting network which may be built from non-critical components. Two cascaded 45-degree networks are fed from a cathode-follower, and oscilloscope is used for checking output of network. Zero or 180-degree shift clearly recognizable on C.R.T. because pattern closes to a straight line.
—**Radio News (U.S.A., Rad. El. Ed.), Nov., 1949, p. 9.**
A C.W. Filter. Circuit and construction of an all-pass C.W. filter of compact design. Uses 6SL7 valves (2) and separate power supply.—**Radio News (U.S.A.), November, 1949, p. 42.**

MATHEMATICS:
Generalized Graphs. A useful article explaining derivation of generalized graphs and how they may be used to assist in design calculations.
—**Wireless World (Eng.), September, 1949, p. 349.**

MICROWAVE TECHNIQUES:
Waveguide Field Patterns in Evanescent Modes. Highly technical article on behaviour of evanescent electromagnetic fields in wave-guides operated below their cut-off frequency. Such fields fall off exponentially with distance and may be used as a reference standard. Field patterns calculated for different fields and field distribution are illustrated by an isometric projection of the surface, showing the electric field in the guide.
—**Wireless Engineer (Eng.), October, 1949, p. 317.**
Calibrated Piston Attenuator. Description of successful attempt to apply piston attenuator to measurement work at wavelengths near to 6 mm. Method of calibrating the variable attenuator detailed.
—**Wireless Engineer (Eng.), October, 1949, p. 322.**

MEASUREMENTS AND TEST GEAR:
Valve Megohmmeter. Circuit of an instrument designed for practically linear scale shape, for simplicity of operation and ease of maintenance; 2 per cent. order of accuracy possible with careful construction. Indicator may be an uncalibrated milliameter of up to 2 or 3 mA (full scale) or a centre-zero indicator. Basic principle is use of true potentiometer circuit with high impedance valve-operated indicator.
—**Wireless World (Eng.), September, 1949, p. 326.**
Audio Signal Generator. (Concluding article; see R. & E. Abstracts, November, 1949, p. 39.) Describes optional refinements—e.g., attenuators. Method of frequency calibration described, using oscilloscope.
—**Wireless World (Eng.), September, 1949, p. 331.**
Direct Reading Timer and Clock. Design and construction of highly accurate intervalometer for 1/100 sec. to 24-hour timing. Circuit and details of equipment of U.S. manufacture.
—**Radio News (U.S.A., Rad. El. Ed.), Nov., 1949, p. 3.**
A Simple Distortion Analyser. Circuit of a test analyser. Uses 6N7 and 6J5 valves in simple circuit.
—**Radio News (U.S.A.), November, 1949, p. 44.**

PROPAGATION:
Painless Prediction of Two-meter Band Openings. Author of article explains method of interpreting weather maps in terms of V.H.F. conditions. Stated that phenomenal high-pressure areas (30.1 or over) always bring improved conditions on 144 mc.—**QST (U.S.A.), October, 1949, p. 22.**

RECEPTION AND RECEIVERS:
Eddystone Model 680. Test report.
—**Wireless World (Eng.), September, 1949, p. 335.**
A Cascade Converter for 144 mc. Triode connected 6AK5 valve used in first stage, inductively neutralized. Second stage uses one-half of 12AT7 (dual triode) valve as grounded grid amplifier. Other half of this valve serves as oscillator. Mixer is 6AK5, triode or pentode connected; 6BA6 I.F. amplifier and built-in power supply. Circuit and constructional details.
—**QST (U.S.A.), October, 1949, p. 12.**
A 1950 V.F.O. Exciter. Corrections to voltage and condenser values shown in original article (QST, Sept., 1949, p. 29).
—**QST (U.S.A.), October, 1949, p. 10.**
A Crystal-controlled Plug-in Converter for the Q5-er. Circuit and construction of converter for use with type BC-453 aircraft receiver. Will tune over 80 and 40-metre bands. Uses single 6BE6 valve.—**QST (U.S.A.), October, 1949, p. 29.**

TRANSMISSION AND TRANSMITTERS:
Tailoring the Series Tuned V.F.O. to Your Needs. Circuit and design of a stable V.F.O.; 6C4 oscillator (3.5 mc.) in Clapp circuit. Two 6F6 isolation stages. Will drive any crystal or multiplier stage in the transmitter with input requirements similar to an 807 valve.
—**QST (U.S.A.), October, 1949, p. 42.**
A "Built-in" 10-Metre Mobile. Circuit and construction of 10-metre transmitter built in to car; 9003 crystal oscillator (7 mc.), 6AQ5 doubler, and 815 amplifier. Modulators are p.p. 6V6—**QST (U.S.A.), October, 1949, p. 19.**

VALVES:
Change of Mutual Conductance with Frequency. The gm of valves with indirectly heated cathodes varies with frequency after about 1000 operating hours. Nature and cause of the change are discussed. Method of greatly reducing phenomenon is explained. Method involves modification to the shape of metal sleeve of cathode.
—**Wireless Engineer (Eng.), October, 1949, p. 331.**

MISCELLANEOUS:
Meteorological Direction Finder. Description of one of the meteorological services in which radio plays an important part. Locating thunderstorms by radar. Equipment illustrated.
—**Wireless World (Eng. Sup.), September, 1949, p. S12.**

QUESTIONS & ANSWERS

VALUES FOR A CIRCUIT

"W.S.H.," Waiti, writes sending us the circuit of a service oscillator, and asking whether we can fill in the circuit component values, which are missing. The circuit is one of those "trick" ones, using a pentagrid converter, a 1C6, as both R.F. and A.F. oscillator, simultaneously. It appears to be quite ingenious, in that the R.F. oscillator circuit is a Hartley, connected between G_1 and G_2, while a peculiar arrangement of the remaining grids and plate acts as an audio oscillator, modulating the R.F. one.

We mention this request because without building the circuit and experimenting with it, there is just no way at all in which circuit values could be recommended with any certainty at all. Owing to the very large number of requests for information which we receive, only a few of which find their way into these pages, the rest being answered direct, it is quite impossible for us to undertake experimental work on behalf of readers, and equally impossible for us to estimate what values should be used in "trick" circuits like this one. We trust that our correspondent will understand our difficulty in this respect, because we would like to be able to assist him, but really cannot with a request of this nature.

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AVAILABILITY OF TYPE 8012

"P.I.," Auckland, writes referring to a statement of ours in the Easter 1949 issue of *Radio and Electronics* in which we mentioned the availability of the 8012 V.H.F. transmitting triode, of which some firms then had stocks from war disposal sources. Our correspondent asks whether supplies are still available, as he would like to purchase a quantity for some experimental work.

Unfortunately, the stocks referred to were not very large, and as was only to be expected, were snapped up by amateur transmitters. So far as we know, no more valves of this type are available, or are likely to be until imports from dollar areas are again allowed.

* * *

NEW ZEALAND AMATEUR TRANSMITTING FREQUENCIES

"N.L.," Albany, West Australia, writes to congratulate us on the standard of our articles, which he compares more than favourably with those of the Australian radio publications, and asks us if we will list for him the New Zealand amateur transmitting frequencies, which he thinks are different from the Australian ones in some details.

We have much pleasure in doing this, as there may be many of our Australian readers who would be glad of the information. The list given below is complete, and includes the New Zealand subdivisions for the different types of emission.

* * *

FREQUENCIES FOR GENERAL USE

7500 to 3960 kc/sec.

This band may be used for C.W., and for A.M. telephony, including S.S.S.C. The portion 3700–3800 kc/sec. is available for N.F.M. with a maximum channel width of 6 kc/sec.

50–54 mc/sec.

This band may be used for C.W. and A.M. telephony, including S.S.S.C. The portion between 50 and 52.5 may be used for N.F.M., while that between 52.5 and 54 mc/sec. may be used for F.M., P.M., and for radio control of models.

144–148 mc/sec.

This band may be used in its entirety for C.W., A.M., S.S.S.C., F.M., and P.M.

420–460 mc/sec.

This band may be used in its entirety for C.W., A.M., S.S.S.C., F.M., and P.M.

The portion between 440 and 460 mc/sec. may be used for radio control of models, and television may be used between 430 and 442 mc/sec.

1215–1300 mc/sec.

As for 144–148 mc/sec., except that pulse transmission also may be used. From 12500 to 1280 mc/sec. may be used for television.

The remaining U.H.F. and S.H.F. bands may be used for all types of emission. They are:—

2300 to 2450 mc/sec.
3300 to 3900 mc/sec.
5650 to 5840 mc/sec.,and
10,000 to 10,500 mc/sec.

FREQUENCIES FOR H.F. PERMIT HOLDERS ONLY

7.0 to 7.3 mc/sec.

C.W. only.

14.0 to 14.4 mc/sec.

C.W. over the whole band, and by special permit only, A.M., and S.S.S.C. from 14.2 to 14.4 mc/sec.

28.0 to 29.7 mc/sec.

C.W. and A.M. or S.S.S.C. telephony over the whole band, N.F.M. being allowed from 29 to 29.7 mc/sec.

Radio Emergency Corps Band

The band 1900 to 1920 kc/sec. is allotted for R.E.C. only, no other amateurs being allowed to use this band.

COMMUNICATIONS RECEIVER DESIGN

"F. M'C.," of Helensville, is designing an all-wave

bandspread tuner and writes with the following queries:

(1) Would it be possible to use two Philips EC52 V.H.F. triodes as mixer and oscillator in place of 6SN7, as shown in some of our earlier circuits?

(2) Would two R.F. amplifier stages be an advantage, and, if so, can an EC52 be used for this purpose, or would a 6SN7 be superior?

These questions go rather deeply into the territory covered by the basic problem of designing a communications receiver, so that they may be best answered by some general remarks on the subject of communications receivers.

The main features that have to be provided in any receiver are (1) high sensitivity; (2) high signal-to-noise ratio; and (3) high ratio of signal response to image response. The first of these is easily come by, as long as the second is achieved, because in a superhet. extra amplification can easily be provided at the intermediate frequency, should it be needed. The second point, signal-to-noise, is often given considerable thought, even at the expense of amplification and image response.

The signal-to-noise ratio of a receiver depends on the design of the early stages, and, especially at high frequencies, is to a large extent bound up with the choice of valves for these stages. Because it has been known for some time that the mixer stage in any receiver is the greatest potential source of noise in the receiver, it is natural that many designers should insist first of all on a low-noise mixer circuit. In addition, we have shown in these pages, on many occasions, and have proved our point by presenting designs for low-noise receivers, that if a triode mixer stage is used, it is very difficult not to make the S/N ratio worse by adding an R.F. stage. In fact, it would appear from this that as long as one uses a triode mixer, R.F. amplifier stages are quite unnecessary. This, however, is not true. Although very satisfactory communications receivers have been designed using triode mixers and no R.F. stages, this is not to say that R.F. stages are of no use whatever. Unless a very high intermediate frequency can be used (and this is not always convenient) the image rejection of a set which has no R.F. stage is frequently not good enough. However, for all frequencies below about 20 mc/sec., a single R.F. stage gives good enough image rejection for most purposes. Two R.F. stages give much better image rejection, but are very difficult to build at all satisfactorily, as evidenced by the fact that only the most expensive communications receivers have more than one. Furthermore, in a set which has two R.F.

stages, but where these are not in perfect alignment, the performance is likely to be much worse than that of a set with only one R.F. stage, properly aligned. At high frequencies, the difficulties of aligning two R.F. stages are such that only a very experienced constructor should tackle the problem, especially where band-switching is contemplated, and no trimmers are to be provided for fine tuning of the R.F. stages.

However, the two-stage enthusiasts who may thus have had cold water poured upon their pet scheme, can take heart, and believe us when we say that when a low-noise mixer stage is used, and one stage of R.F. amplification, the amount to be gained by adding a second R.F. stage is so slight, that for the amateur designer it is not worth the trouble and expense of providing it. Briefly, then, the answer to query (2) is that two stages are not worth the candle.

There is no apparent reason why a pair of EC52's should not be used as triode mixer and oscillator, and depending on the lay-out that it is desired to use, the separate valves may have some advantage over the double tube. It is certainly easier to get a good lay-out of the circuit if separate valves are used for mixer and oscillator. As to this point, the constructor might well please himself. Ordinarily, though, the double tube will be preferred on the score of expense.

With regard to question (2), our correspondent asks whether an EC52 could not be used instead of a 6SN7 as an R.F. amplifier. We take it that he is referring to the 6SN7 R.F. amplifier circuit of the cathode-coupled variety, in which the first half is used as a cathode follower, and the second as a grounded-grid stage, the cathodes being connected together. If this is so, the EC52 cannot be used to represent a 6SN7, since the former is only a single triode. A pair of EC52's could be used in a similar circuit to the cathode-coupled 6SN7 one, but we do not recommend this, because the two separate tubes would not be so satisfactory at the high frequencies, owing to the longer leads between the two triodes. Quite the best valve for the cathode-coupled R.F. amplifier circuit is the 6J6, or its equivalent, the ECC91. This is because this tube has a very high mutual conductance, and also because there is only one cathode, and no lead at all between the cathodes of the two halves of the valve.

To sum up, we would suggest that an excellent tube line-up would be: R.F. amplifier, 6J6 or ECC91, in cathode-coupled circuit; mixer, EC52; oscillator, EC52; I.F. amplifier, 6BA6.

THE "80-40-20 BANDSPREAD TUNER"

"W.D.," of Invercargill, writes with some questions regarding the "80-40-20" Bandspread Tuner, described in the November and December 1949 issues of *Radio and Electronics*. First, he wants to know whether we can supply details of coils needed for setting up the tuner on the short-wave broadcast bands instead of the amateur bands, as at present arranged. Further, he asks whether such a tuner could be built as a complete set together with a good audio amplifier.

Unfortunately, the question of coils for the S.W. broadcast bands has not yet been gone into in detail, as a good deal of work is involved. We cannot give details at the moment, therefore, but the question is one likely

(Concluded on next page.)

to be of sufficient interest to readers to enable us to re-design the tuner with short-wave listeners in mind. The scheme would be to add a set of broadcast coils, retain the 80m. amateur band, as being of interest to listeners as well as "hams," and to add coils covering the main short-wave broadcast bands. This would wind up by being considerably more complicated than the "80-40-20" tuner, as more coils would be involved, but the principle would be just the same, and the new unit would simply represent more work on the part of the builder. We will be pleased to look into this matter, because we feel sure that a unit of the kind mentioned would be of considerable interest.

* * *

THE "R. & E." 420 mc/sec. TRANSMITTER-RECEIVER

"H.E.B.," of Christchurch, writes:—

"As a keen follower of *Radio and Electronics,* I read an article on the building of a 420 mc/sec. transceiver, in the October and November issues, 1949. Now, as a V.H.F. and U.H.F. bookworm, I would like to ask you if it is possible to tell me of a firm which would build me one of these transceivers, as I have very little time for building purposes."

This is a difficult question, because although there are several firms which build special equipment to order, none of them are very keen on jobs of this nature, because invariably a new job gives a number of "headaches" to the manufacturer, with the result that for only one of a thing, he is forced to charge a price that could be quite prohibitive. If he could get an order for several, the price of each would be correspondingly lower. However, we suggest that by advertising, or otherwise, our correspondent may be able to make contact with another amateur who may be able to build the transceiver for him at a reasonable cost. The cost of materials is quite small.

RADIO MANUFACTURERS CONCERNED INCREASED "INTERFERENCE" NOISE

Man-made interference noises in radio reception are increasing, and the New Zeaalnd Radio Manufacturers' Federation is taking steps to see that, in the interests of all listeners, this nuisance is progressively reduced. At the Federation's annual conference in Wairakei a report on special investigations carried out by Mr. P. C. Collier, vice-president, was tabled. "Listeners do not generally realize what a volume of unwanted power is radiated by electrical instruments of every type and picked up by radio receiving sets," said Mr. Collier. "There are no technical means of building into sets features which would filter out such unwanted interference and the trouble will have to be tackled at the source. Manufacturers regard it as their duty not only to design, build, and make available to the public sets of the highest possible quality and performance; they also feel that it is their concern to see that reception conditions as near as possible to perfect exist for the listening public."

Some examples of causes of set noises were given. In cities, trams and trolley buses had been shown to have an interference radius of two miles, and tests showed that one of the main nuisances was caused by the low frequency "stop" buzzers in trams. Radiation of distortion products of power conversion equipment feeding tram and railway traction systems were equally serious sources of interference. Motor vehicles, small motors in such machinery as sewing machines, vacuum cleaners and electric shavers, all contributed their share of unwanted noise.

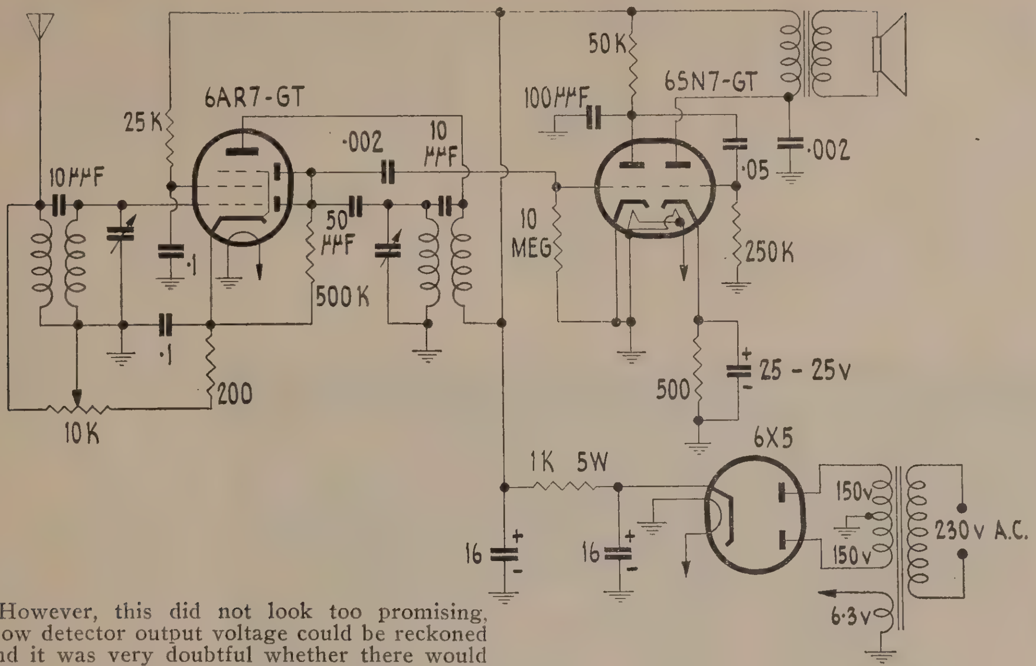
"A potentially serious factor considering the inevitable extensive development of fluorescent lighting was the interference possibility of certain units either as a result of poor design or through changes in discharge characteristics of the tubes themselves during their normal life. Under certain conditions these devices are capable of radiating heavy interference although perhaps limited in extent.

"In the country, power transmission, particularly medium voltage lines, can cause serious noise. More recently steps have been taken to ensure that new lines are more suitably insulated but there are still thousands of miles of power lines radiating their quota of potential set noises," Mr. Collier said.

"Other countries have come up against this problem already, and we can learn from their experiences. Let us make it our business," he continued, "to see that man-made interference does not degrade the quality of the products we make or detract from the value of radio listening as a form of entertainment. We shall have to start now a long-range programme of reducing what is already a serious nuisance, and although the fault does not lie with us as radio manufacturers we must take the responsibility of getting at the causes of the trouble."

Mr. W. J. Blackwell, Federation President, emphasized the importance of the report for every family in the country. "There is hardly a home in New Zealand without its radio set—in fact, many homes have several sets. Everybody is entitled to the very best reception of broadcast programmes, and we must help them to get this. The standard of radio sets in New Zealand is very high indeed; testing standards and processes are more stringent than in most overseas countries. The public is discriminating and critical, and there is an increasing taste for good quality in its radio fare."

Mr. W. J. Blackwell was re-elected president and Mr. P. C. Collier vice-president for the ensuing year.

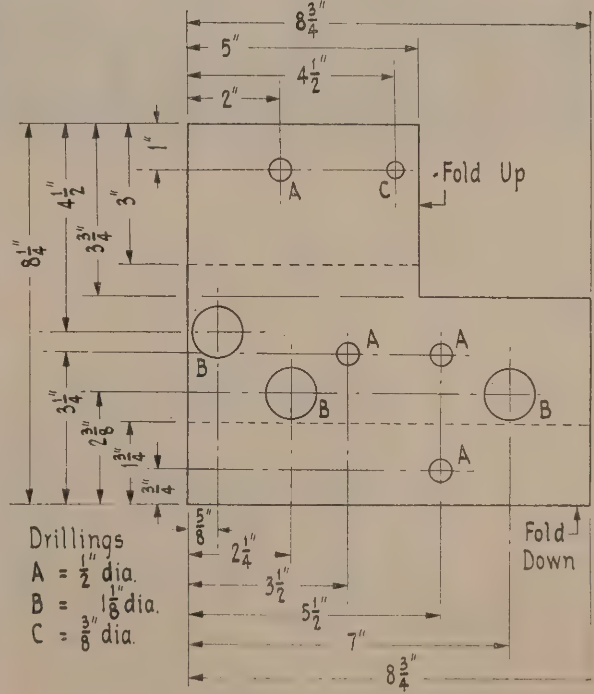


KT61. However, this did not look too promising, since a low detector output voltage could be reckoned upon, and it was very doubtful whether there would be enough to excite even an output valve of this type. Apparent deadlock!

However, there is a way out of most difficulties if only it can be found, and before long someone had a brainwave, and of considerable frequency at that. Why, it was argued, should we continue to think in terms of the usual output power of 3 watts or more? Does not the portable receiver get along quite nicely on a maximum power output (not undistorted) of a few miserable milliwatts? It does, of course, although we have heard of complaints from members of the general public that their personal portable will not make as much noise as the sets at home! In other words, is your power output strictly necessary? In the case of a midget set, whether battery operated or not, we think the answer is "No," though we do not think that it should be restricted to 80 or 100 milliwatts if the owner is to be satisfied.

As a result, the idea came forth of using a valve which would produce a power output of, say, a quarter of a watt, and of using as a power valve one which is not normally considered as such. Reference to published material shows that a single 6J5, or one-half of a 6SN7, which is the same thing, is capable of turning out approximately 0.5 watts if operated as a power amplifier, with a plate voltage of 250 and a grid input voltage of 9 volts peak. It looked as though the same valve would still have plenty up its sleeve with reduced plate voltage and grid drive. The only thing to do was to try it. If we used a 6SN7, one-half could be used as a resistance-coupled audio amplifier and the other as the output stage. The first half would have a voltage gain of, say, 14 times at least, so that, with a peak driving voltage of about 7 volts, an output of only 0.5 volts peak from the detector would give us maximum output. On paper, then, the scheme seemed highly feasible. The circuit was built up and the results were even better than expected.

The output power achieved was quite sufficient for normal listening in a medium sized room—in fact, more than sufficient—and all the Wellington locals were received at good strength. It was even possible

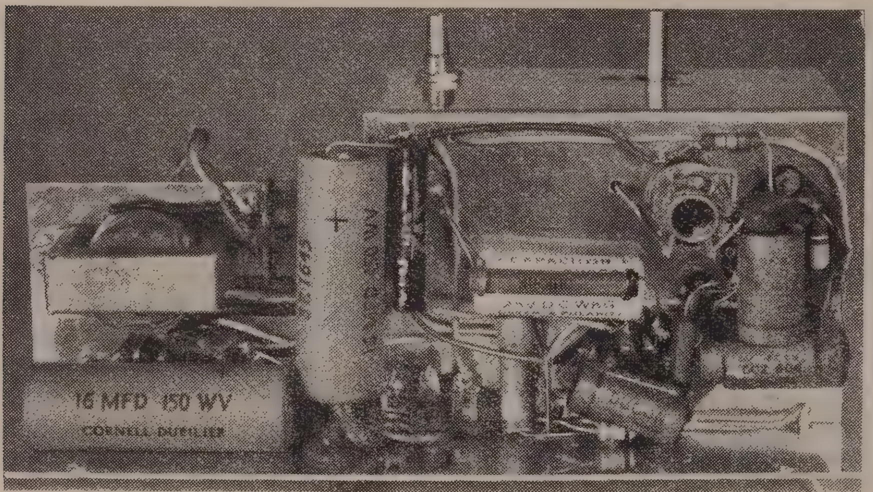


to hear 3YA, although to copy what they were saying would have necessitated using the loudspeaker as a headphone. Incidentally, the set is perfectly stable, and does not rely on unintentional regeneration and near oscillation for its R.F. sensitivity. In short, for a small, cheap set, with very presentable tone (considering the 3 in. speaker that was used in the interests of compactness), we think that this circuit will be found hard to beat. Construction, too, is

of the simplest, and the set would thus be an excellent one for the beginner to tackle as his first A.C. operated job.

THE CIRCUIT

Apart from the somewhat unconventional valve line-up, the set is quite ordinary, except perhaps in the detector diode circuit, where a shunt rectifier is used because it is not possible to have both sides of the tuned circuit above earth potential for D.C. Ordinary aerial and R.F. coils are used, but these need to be of as high quality as possible, because the gain of the set is limited and we have to make the most of the R.F. amplification available in a single stage. The volume control arrangement calls for some comment these days, although it was at one time a very common one, especially in the days before the general use of automatic gain control. The 10k. potentiometer in the cathode circuit of the R.F. amplifier serves a dual purpose. In the first place, it adds resistance to the cathode circuit, thereby increasing the bias on the 6AR7-GT. This on its own, however, is not a very good scheme, because a simple variable cathode resistor does not give a very great variation of gain in practice.



An improvement can be effected by applying a positive voltage to the cathode by means of a resistor connected from H.T. This gives plenty of available bias control, but has the disadvantage that, although it decreases the gain of the stage, it does nothing about reducing the signal fed into the grid of the valve. As a result, a very strong local signal can sometimes cause severe distortion by overloading the grid circuit. Thus, the free end of the volume control is connected to the aerial terminal. When the moving arm is at the right and the gain is high, the potentiometer acts only as a high-resistance shunt on the primary of the aerial coil and has no observable effect. However, when at the other end, and the valve gain is reduced, only a low resistance shunts the aerial coil, causing a drastic reduction in the R.F. voltage developed at that point by the aerial. Thus, great control is provided, and at the same time the risk of valve overload is greatly reduced.

For two reasons, the first half of the 6SN7-GT is biased by the grid leak method. First, it saves components, as no cathode resistor or bypass condenser is needed. Secondly, the high grid leak value of 10 megs. has two further beneficial effects. The shunting on the diode load resistor of 500k. is reduced to negligible proportions, with the result that detector distortion is minimized. Further, the high grid leak makes it unnecessary to insert an R.F. choke between the diode and the amplifier grid. How this comes about may not be immediately apparent. However, the input capacity of the audio valve is, due to Miller effect, much greater than the inter-electrode capacities themselves, and, indeed, has a value of approximately 50 $\mu\mu$f.

When shunted across a very high resistance, this capacity is quite large enough to strongly attenuate any R.F. voltage that may be present at the grid of the audio amplifier. With a 10 meg. grid leak, this input capacity is an effective R.F. bypass, but with a more usual grid leak, say, 1 meg., it would only be one-tenth as effective, and a choke would be necessary to prevent R.F. from getting into the audio section of the set.

The output stage is not at all out of the ordinary, except for the fact that a high-impedance transformer primary is needed, owing to the large plate resistance of the small triode used. A transformer which matches an impedance of 12,000 ohms or higher to the voice coil of the speaker will be quite satisfactory, although the optimum is in the region of 15,000 ohms.

The power supply requirements are very light, as already explained, and a small instrument-type power transformer, giving 150 volts-a-side at a current of 30 ma., will be amply big enough. The 6X5 is used as the rectifier because it does not need a separate filament winding, as do the other rectifiers, and also because 6X5's can be got very cheaply these days.

The smoothing filter uses a resistor instead of a choke, and the hum level is plenty low enough, especially seeing that a midget speaker will be used, which does not reproduce low frequencies well enough to give much output from a little hum voltage.

CONSTRUCTION

The construction of the set should be fairly clear from the photographs and the working drawing of the chassis. This is made from 16-gauge aluminium sheet, and consists of nothing more than a flat sheet of the shape and dimensions shown in the drawing, bent so that a front flange comes upwards from the chassis, and a back one, downwards.

The midget two-gang condenser is mounted to the front flange by means of three screws which go into threaded holes already provided in the front plate of the condenser. The type used was without trimmers, and these can be seen mounted on top of the gang as mounted (on its side).

The other ⅜ in. hole in the front flange is for the volume potentiometer, which can be seen in the photograph. The large object behind the volume control is the power transformer, and beside it, to the right, is the rectifier valve. The 6AR7-GT is the valve with

the top-cap, and is opposite the gang condenser. In front of this valve is the aerial coil, the R.F. coil being mounted underneath the chassis, where it can be seen in the other photograph. Directly behind the gang can be seen the 6SN7, separated from the aerial coil by a small shield. This can be made of the same material as the chassis, and was found necessary for stability. On no account should it be omitted.

Looking at the underneath view, we can see the output transformer right at the left, and beside it the two 16 μf. electrolytic smoothing condensers. The oscillator coil can be seen directly below the tuning shaft, which is the right-hand one in the photograph.

ALIGNMENT

The building of the set offers no difficulties, nor does the alignment, but reasonable care should be taken with both if the performance is to be as good as possible.

The alignment is simplicity itself. Once a signal has been received, and there will be no difficulty about this, even if the trimmers are far from their correct settings, all that has to be done is to choose a station at the high-frequency end of the broadcast band and tune it in as accurately as possible, having first set one of the trimmers (it does not matter which) at about mid-setting. Then the remaining trimmer is carefully adjusted for maximum response, taking care to leave the other strictly alone. With a T.R.F., this is all the alignment that can be done, the tracking at other points on the dial being dependent entirely on the equality of the coils and the sections of the gang condenser.

Finally, do not expect to get DX results from a set of this sort. It is strictly a local-station receiver only, and cannot be expected to work well except on an aerial of reasonable length. Even so, the pick-up provided by 10 feet or so of wire hung across the room will be sufficient for receiving all but the weak local stations, and if a large outdoor aerial is available, the results will be surprising, even for such a small set.

"RADIO AND ELECTRONICS"

Back and current numbers of "Radio and Electronics" may be obtained from—

Te Aro Book Depot, Courtenay Place, Wellington.
S.O.S. Radio, Ltd., 283 Queen Street, Auckland.
S.O.S. Radio, Ltd., 1 Ward Street, Hamilton.
Tricity House, 209 Manchester St., Christchurch.
Ken's Newsagency, 133–135 Stuart St., Dunedin.

PHILIPS Experimenter

(Continued from page 35.)

AERIAL COUPLING ARRANGEMENTS

In some transmitters the question of coupling to the aerial receives little or even no consideration from the manufacturer at all, and some transmitters designed for amateur construction show a like lack of appreciation of the prime function of the thing, which, after all, is not only to generate R.F. power, but to radiate it. For this reason, the aerial and the devices used for coupling the transmitter to it efficiently are really a part of the transmitter. One does not make a motor-car without wheels and inform the purchaser that they are his to provide!

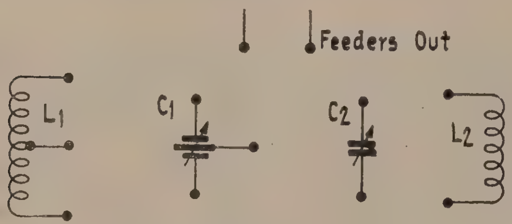


Fig. 4

The final touch will therefore be added to the Philips transmitter by the incorporation of a versatile aerial coupling unit which will enable efficient coupling to be had to any of the usual types of aerial that are to be found in use by amateur transmitters. The unit will be mounted in a chassis of its own, which makes up the top panel of the completed transmitter. In order to give the utmost in flexibility, the coupling unit will not really consist of a built-up unit at all, but only of a number of suitable components suitably disposed in such a way that by connecting the required ones together by flexible leads,

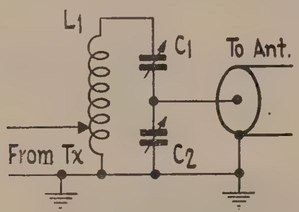


Fig. 5

terminated in spring clips, any desired coupling circuit may be built in a few moments. The "circuit" of the coupling unit then consists of two coils, one of which is centre-tapped, two variable condensers, one of which is a split-stator, and two free terminals to which feeders or co-axial cable may be connected. This is illustrated in Fig. 4. Each part is provided with terminals, and is insulated completely from the chassis, so that any configuration can be used whether or not it is balanced with respect to ground.

Two of the many possible methods of connecting up the components are shown in Figs. 5 and 6. Fig. 5 shows one of the stock methods for feeding a low-impedance coaxial cable. Here, the circuit is single-ended, so that one side must be earthed to the chassis. C_1 is used with sections connected in parallel, as a single condenser, and L_1 is used with its centre-tap open. L_2 is not needed in this case.

C_1 should be similar and preferably identical with the tank condenser used for the final amplifier, while C_2 should have a large maximum capacity—say, 350 $\mu\mu$f. or larger. The insulation and spacing of C_1 needs to be similar to that of the final tank condenser, but C_2 is used only in such a way that it never has high R.F. voltages across it and so can have quite close spacing.

Fig. 6 shows an excellent scheme that is not very well known for feeding a balanced line. It can be used with tuned or untuned lines of any impedance, and has the great advantage that for tuned lines there is no necessity to switch condensers from series to parallel in order to tune lines of different lengths. In Fig. 6 it will be noted that C_2 and L_2 have their connecting wires dotted. This is to indicate that only one of them is needed at a time and only when feeding lines that have standing waves on them. For lines that really are "untuned" and so have no standing waves on them, neither C_2 nor L_2 is needed. Now, there is no essential difference between a "tuned" line and an untuned line that has standing waves on it. In the former case, the standing waves are there intentionally, and in the second, unintentionally, and only because there is a mismatch between the aerial and the line, but in either case we

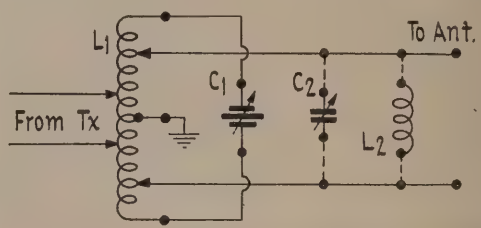


Fig. 6

have to tune out the reactance that the line exhibits, so that the procedure for feeding either sort of line becomes identical. The only difference in tuning procedure for the untuned line is that the shunt capacity or inductance is found during the tuning-up process to be unnecessary. In order to avoid the necessity for winding coils for each band, coils are tapped at each turn so that shorting links can be used to reduce the inductance to the value required for each band.

The final amplifier has a swinging link for varying the coupling to the tank circuit, but, since this effectively prevents D.C. voltages from passing into the coupling circuit, it is possible to use direct connection between the link and the aerial tuning arrangements whatever the actual circuit that is used. This saves a good deal of construction and makes quite adequate variation of the coupling, even though continuous variation is not possible.

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NON-COMMERCIAL EXHIBITS AT THE THE 1949 RADIOLYMPIA

Some of the most interesting exhibits at Britain's 1949 Radiolympia were those of the armed services and other Government departments. A brief description of some of them appears below.

MINISTRY OF SUPPLY

Radar Research and Development Establishment:

A radar system was demonstrated using supersonic waves travelling through a tank of water to simulate radio waves sent out by a normal radar set. As these supersonic waves travel more slowly in water, the distance in the tank was equivalent to 50 miles in the ether. The waves send back an echo if they strike an object in the water, which is reproduced on a cathode-ray tube in the same way as an echo from an aircraft would appear on the plan position indicator of a radar set.

Signals Research and Development Establishment:

Among the exhibits was the pulse method fault locater used to trace faults in army telephone lines and cables. The instrument sends a pulse of current along the line to be tested and is reflected back by any break or short circuit. The time interval between transmission of the pulse and its return enables the fault to be accurately located.

Pulse code modulation, developed by the establishment, was also demonstrated. The system translates spoken words into "telegraph" symbols, and enables speech to be transmitted without interference by noise or distortion. Visitors to the stand saw a BBC programme, received on a direct line, turned into pulses visible on a cathode-ray tube, and passed through a further instrument which retranslated the symbols into normal speech.

Royal Aircraft Establishment, Farnborough:

A warning system for aircraft shown was a device which has various signals and spoken phrases pre-recorded on plastic tape and automatically operates when something goes wrong with the aircraft, such as failure of the fuel supply.

Telecommunications Research Establishment:

A new method of packaging was displayed by which small electronic components are heat-sealed in bags of strong, transparent polythene film. It is claimed that this method gives greater protection under all climatic conditions and is cheaper than existing methods.

MINISTRY OF CIVIL AVIATION

A working model, 10 ft. x 4 ft., of the main runway at London Airport, complete with approach, runway, and taxiway lighting was shown. A model three-inch aircraft took off from the runway in semi-darkness and circled the airport. Before coming in to land after its three-and-a-half-minute flight, the aircraft was picked up by radar, which gave, on the radar screens in full public view, the range and azimuth bearing of the aircraft and its exact position in relation to the model runway at every stage of approach. Although artificially generated, the radar signals were accurate. Automatically co-ordinated with these signals were heard recorded talk-down instructions from the ground control approach radar controller based on his interpretation of the moving "blips" on the radar screens. The pilot's answers were also reproduced.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

On a large chart map of the British Isles were the position of thunderstorms based on readings received direct from four plotting stations—Dunstable, Camborne, Leuchars (Scotland), and Irvinestown (N. Ireland). The cathode-ray direction finders used in these stations receive radio frequency signals emitted by a lightning flash, and determines their direction of arrival. The network provides information on the position of storms up to a range of 1500 miles, and is invaluable in the preparation of weather charts and for planning aircraft routes. The stations are in use for about 12 periods of 15 minutes each day.

Another demonstration showed how the height and density of ionization is recorded for forecasting the best frequencies to be used for radio communication between any two points on the surface of the earth. (The ionosphere is that part of the atmosphere capable of reflecting radio waves and ensuring their propagation to a distance.) The D.S.I.R. operates apparatus in England, Scotland, Falkland Islands, and Singapore, and the results of these measurements are exchanged with other national radio organizations using similar recorders.

ROYAL AIR FORCE

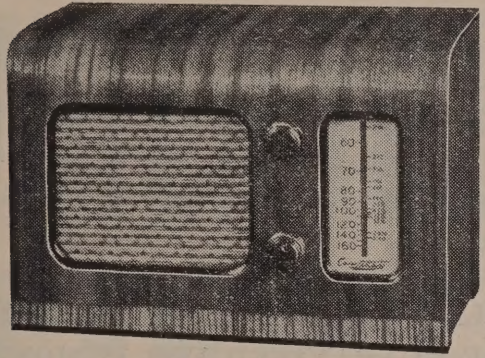
A central feature was a scale model of a typical permanent R.A.F. station showing the siting of the various navigational aids, hangars, workshops, administration buildings, living quarters, sports grounds, and other amenities. The model enabled visitors to appreciate the lay-out of a station—not always possible when visiting an actual station.

A demonstration of the radio-teleprinter system showed how signals are sent between air force units at home and abroad. Members of the public were invited to write a message on the appropriate R.A.F. form and hand it to a signals operator. The exact service procedure was followed, and the signal was transmitted to the other side of the stand, where the sender collected his message and kept it as a souvenir.

Visitors were able to enter and inspect a mobile radar plotting vehicle, in which the methods used for plotting radar information and carrying out controlled interception of aircraft were demonstrated.

NEW PRODUCTS: LATEST RELEASES IN ELECTRONIC EQUIPMENT

COURTENAY MODEL 5 "TALISMAN"
(Turnbull and Jones Ltd.)



The newest release in the "Courtenay" range of sets is the Model 5 "Talisman"—a 5-valve midget set with broadcast coverage designed to fill a low price demand.

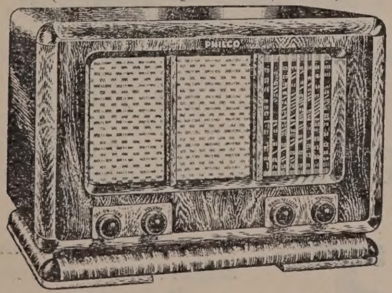
The Model 5 has some unusual features including low-loss P.V.C. built-in loop aerial to eliminate the necessity for an outside aerial when listening to main stations and allows the set to be carried from room to room without trailing unsightly wires. A polystrene iron-cored adjustable oscillator coil, floodlit type dial with principal stations marked, switch-on volume control and 5-inch E.M. speaker complete the main features.

Valve line-up is: 6BE6 pentagrid converter, 6BA6, I.F. amplifier, 6AV6, a.v.c-second detector-audio amplifier, 6V6GT output, and 6X5GT rectifier.

The set is most attractively housed in a walnut cabinet.

Initial deliveries of this model were sold right out but the main production is now available for ex stock delivery. The New Zealand distributors—Messrs. Turnbull and Jones, Ltd.—expect a strong demand for this model.

"PHILCO" Model 860 (8-valve A.W.)
(Russell Import Co., Ltd.)



Philco's latest addition to their extensive range is Model 860, which is a de luxe spread-band 8-valve mantel radio, featuring all of the latest developments from the Philco Research Laboratories, U.S.A.

Designed for the discriminating listener who demands fidelity of reproduction with outstanding distance achieving ability, this receiver sets a standard hitherto obtainable only from sets in the three-figure category.

Wavebands are spread over an exceedingly wide range, there being a separate full-scale band for each of the 13, 16, 19, 25, and 31-metre bands, besides the two normal shortwave bands covering from 2.5 m/cs. to 22 m/cs. With more than 100 shortwave stations inscribed on the dial, no two stations are closer together than one-eighth of an inch.

Using a special Philco superheterodyne circuit with push-pull output system, variable bass compensation, and double-tuned I.F. transformers, the performance of this Model 860 is in the "super" class.

Tube complement is as follows: 1 7A7 R.F., 1 7J7 oscillator-mixer, 1 77A I.F., 1 7B5 second detector, 1 76 first audio, 2 42 P.P. output, 1 80 rectifier.

The chromium-plated chassis is housed in a superlative cabinet of Queensland maple and Brazilian rosewood, which, coupled with the striking ivory and gold grille cloth forms a really beautiful cabinet of pleasing and yet distinctive appearance. Model 860 is a worthy addition to the already famous range of Philco receivers.

"RADIO ELECTRONICS"

Back and current numbers of "Radio and Electronics" may be obtained from:—

Te Aro Book Depot, Courtenay Place, Wellington.
S.O.S. Radio, Ltd., 283 Queen Street, Auckland.
S.O.S. Radio, Ltd., 1 Ward Street, Hamilton.
Tricity House, 209 Manchester St., Christchurch.
Ken's Newsagency, 133-135 Stuart St., Dunedin.

PORTABLE SOUND SYSTEM

(Continued from page 13.)

pushed in, so that the complete sound system can be carried with one hand, leaving the other hand free for carrying the records or for steadying the fences on the way home!

AUDIO OSCILLATOR

(Continued from page 16.)

R_{26}, R_{27}, and R_{25}, has no values assigned. The reason for this is that the exact amount of attenuation required in the first section might vary with individual oscillators. In the original one, the output was approximately 12.5 volts, so that an attenuation of 1.25 times was needed to bring the output at the input terminal of the first 20 db. section to exactly 10 volts. This attenuation is almost exactly 2 db. For this, the required values are 111 ohms for R_{26} and R_{27}, and 4,400 ohms for R_{25}.

For those who might wish to work out their own values, in case the attenuation for their own front section is widely different from the original, the following formulae can be used.

For R_{26} and R_{27},

$$R = \frac{1000\,(A-1)}{(A+1)}$$

and for R_{25}

$$R = \frac{2000A}{(A^2-1)}$$

In both these formulae, A is the amount of attenuation required, and is equal to Input ÷ Output.

When the attenuators have been installed, the instrument is complete.

DYNAMIC NOISE-SUPPRESSION

(Continued from page 21.)

In requisitioning the chokes, it should be pointed out that they are for use in this circuit, and that the inductances need to be reasonably accurate. They also need to have as high a Q as possible, so that the cut-off curves will be sharp, as indicated in Fig. 2.

Apart from the provision of the chokes, there is no reason why every success should not be obtained with the dynamic noise suppressor, which offers a very useful field for experiment, both with amateur and commercial equipment.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